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SCHOOL SCIENCE AND MATHEMATICS

VOL. XLIX NOVEMBER, 1949 WHOLE NO. 433

MEET THE AUTHORS OF OUR ANNIVERSARY BOOK

The anniversary book is rapidly developing into a completed manuscript. Author of the section on Mathematics is

DR. ERNST R. BRESLICH

He is an alumnus of Chicago University. Both the M. A. and Ph. D. degrees were awarded him by that university. Here he also was a member of the faculty until his recent retirement. As charter member and former president (1941) of C. A. S. M. T. he is well informed on affairs of our Association. Dr. Breslich's family circle includes his wife and four children.

Besides a number of articles, and, as he writes, "several lesser publications," he is author of two series of textbooks on mathematics. One series is published by the University of Chicago Press and the other by Laidlaw Brothers. Both *Who's Who in America* and *American Men of Science* list his name.

Author of the section on the personal history of the Association is our Historian

EDWIN W. SCHREIBER

Mr. Schreiber received his A. B. from Michigan University (1911) and the M. A. from the University of Chicago (1924). Besides these studies he carried additional graduate work at the University of Michigan and the University of California, As teacher he served schools in widely scattered geographical areas. He began his teaching at University School for Boys, Chicago, 1911–1912. As Head of the Science and Mathematics Departments he served: Yuma Union High School (Arizona), 1912–1914; New Castle (Pennsylvania) High School, 1914–1917; Proviso Township High School, Maywood, Illinois, 1917–1927. He was visiting lecturer in mathematics at the

University of Wisconsin during the summers of 1929 and 1930. Since 1929 Mr. Schreiber is Head of the Mathematics Department at Western Illinois State College, Macomb, Illinois. His affiliation with our Association began in 1918. He served on the Board of Directors for two terms (1929–1931 and 1940–1942). Since 1943 he officiates as our Historian. Mr. Schreiber is author of numerous articles in professional journals, and is listed in *American Men of Science.* Mrs. Elizabeth Schreiber and son Robert are the members of the immediate family circle.

Mr. Ira C. Davis, Association president in 1938, is senior co-author of the section on physical sciences and Mr. Jerome Isenbarger, Association president in 1919 is senior co-author of the section on biological sciences.

RESEARCH ACTIVITIES OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

In 1948 the Central Association of Science and Mathematics Teachers initiated the development of five research projects. These were recommended by the Policy and Resolutions Committee of 1947, and have been titled The Policy Projects. Subcommittees have been appointed to develop materials and techniques for these projects. Personnel for these committees were selected from both science and mathematics divisions of the high schools and colleges. At least a three-year period, and perhaps longer, will be needed to develop each project to the point of useful manipulation. It is planned that varying presentation methods will be used—articles in SCHOOL SCIENCE AND MATHEMATICS, special pamphlets or circulars, and papers for presentation at science and mathematics meetings.

The five projects are:

1. A program to meet individual differences of high school students.
2. Better laboratories, materials and visual aids.
3. Better evaluation techniques.
4. Teacher research in daily classes.

In 1948 a mimeographed report of preliminary investigations was made to members of Central Association. At the convention on November 25 and 26 at the Edgewater Beach Hotel, Chicago, the chairman of the Policy and Resolutions Committee who is also Vice-President of the Association, will give a progress report on the Policy Projects during the Saturday morning General Session.

CHARLOTTE L. GRANT, *President*

REVIEWING AND SELECTING NATURE BOOKS FOR CHILDREN*

EVA L. GORDON
Cornell University, Ithaca, New York

As I thought about this program, it seemed to me that my place in it was that of a "middleman" between the producers of children's nature books, as represented by Miss Patch and Mrs. Hamilton, and the consumers, whose problem was presented by Mr. Blough. Just as the job of any middleman reaches toward both the producer and the consumer, so, it seems to me, the reviewer and selector of nature books—or of any books, for that matter—could and should contribute in both directions.

First, let me tell briefly how I got into this business of nature-book selection. Through work with teachers-in-service, in courses on the teaching of nature study and elementary science, I met questions such as "What book will help us learn about rocks—or insects—or what-have-you?" Or some teacher said, "I found this book in the library—is it any good?" Or, "I have some money to buy books. What would you suggest?" Parents whom I knew asked similar questions; and last, but not least, there were the Cornell Rural School Leaflets, each with a particular demand for suggestions of references and sources of information of use to teachers. I found myself ambitiously trying to become thoroughly acquainted with every book I could find that seemed at all likely to be of value to impart nature interest and information to children, particularly of elementary-school age. Catalogs, selective lists of all kinds, particularly of nature and science books, reviews and all sorts of sources were examined to discover titles.

Books classed as nature or science books are a varied lot. Even lists prepared or sponsored by workers in science education showed wide diversity in type and quality of books. Books ranged from folklore and fantasy to the coldly factual encyclopedic type. What constitutes a nature book, and where to draw a line—if a line can be drawn—between nature books and non-nature books are difficult questions. And what constitutes a good nature or science book for children is even more difficult to say.

A good nature book should, of course, meet the general standards used in measuring the worth of a child's book in any field. After examining some 1200 books, however, I found myself evaluating

* This paper was presented at the Annual Meeting of the American Nature Study Society, December, 1948. Annotated lists of books related to this discussion are contained in the Cornell Rural School Leaflets for September, 1938, and September, 1949, both available at twenty cents each from Cornell Rural School Leaflet, Cornell University, Ithaca, New York.

individual volumes on the basis of both these general criteria and a number of others having to do definitely with scientific values as I saw them. To the discussion of these special standards I plan to devote much of my time. But, first let me emphasize that what I have to say is the result of one person's experience, and is of value only on that basis. If you will keep that in mind it will save lots of "It seems to me" or "I believe that."

One could scarcely emerge from such extensive reading in a special field without some ideas about books and book production: a feeling that some fields are possibly oversupplied, while others need additional materials; some suggestions for pre-publication precautions that would contribute to better quality in the product; and some comments on reviews and reviewing from the standpoint of would-be users of books in this field, many of whom must rely on judgments other than their own.

Let's take first some of the qualities that have seemed particularly significant in evaluating nature and science books for children. Although these criteria were developed chiefly from examination of non-textbooks, it is believed that the same general considerations would apply to textbooks. Such qualities may be grouped in at least three classes: those concerned with the books themselves, qualities of content and format which can be judged by examination of individual books; those concerned with the preparation and production of books, such as author's purpose and background, the illustrator, the publisher and his policies, and cost; and those concerned with the reviewer or selector, his purpose, background and personal preferences.

Content is obviously the most important of the factors concerned with the books themselves. The subject-matter field and the scope of content are first considerations of the reviewer: with what materials a given book deals and the breadth, or detail, or emphasis with which its subject is treated. Children's nature books vary as widely in scope as in subject-matter, from a tiny book that deals with so simple a subject as the seasonal growth of an apple tree to one that attempts to survey the entire plant and animal kingdoms. What a book does and does not do determine to a large extent its usefulness to any given prospective reader, and the reviewer who fails to give an adequate description of content is limiting the value of his contribution. The highly generalized descriptions which frequently appear in brief annotations often fail in this respect, and give little information beyond that implied in the title.

Most persons asked to suggest the most important quality of children's books in nature and science, probably would name accuracy. As I have worked with these books I have come to feel that accuracy, whether of text or of illustration, is not simply a matter of

correct factual detail, although I cannot emphasize enough my belief that books should be as free from misstatement and incorrect illustration as is humanly possible. It seems to me that there is no reasonable excuse for a statement such as the following—and I quote: "The pistil is the organ bearing the ovule, which is the bud inside it. The part of the plant which contains the pollen is called the anther, part of the pistil," which appeared in a comparatively recent, widely publicized book. Of course, such statements can be put to use by one who recognizes them as inaccuracies to develop in children the habit of evaluating sources of information, but that possibility does not seem sufficient justification for failing to insure that, factually, material is in accord with the knowledge of recognized specialists. It is satisfying to note that careful attention to this factor is increasingly evident.

Accuracy, however, seems a much more complex matter than avoidance of vagueness or misstatement. It implies, for one thing, discrimination between proved or demonstrable truth and theory or hypothesis. An explanation of the origin of the universe or a description of the habits and appearance of prehistoric animals may be stated not as what we believe to be possible on the basis of evidence we have, but in terms as positive as might be used to tell how one made his garden or to describe the appearance and behavior of a pet cat. Accuracy means also, a willingness to say "I don't know," and in general, avoidance of sweeping statements and sparing use of such words as "all," "every," and "always." It means, too, careful expression in terms not necessarily technical, but at least not in conflict with scientific language that will come into the child's later experience. One "horrible example" in this respect concerns a frog, who, telling the story of his life, described the appearance of his legs and the disappearance of his tail, and finished by saying, "the very day that my tail disappeared I found that I could jump out of the water. I was no longer a fish. I was an animal—an animal—animal." Good performance in this matter of careful expression, always practiced by some authors, seems to be shown increasingly in the newer books, sometimes in judicious use of scientific names, and frequently in the use of well-defined, carefully explained terms instead of awkward, written-down expressions. More and more authors seem to recognize that a child able to talk about accelerators and ailerons and chrysanthemums and such does not need to have nectar called "the sweet juice of flowers" and can comprehend the distinction between "animal" and "mammal," or "bug" and "insect."

Accuracy is closely related, too, to type of presentation, a much discussed question among producers and users of children's nature books, and one which evidently has no answer, judging from the

variety of methods and devices used to sugar-coat or otherwise prepare the facts of nature for consumption by young readers. There is, first and foremost, what might be called direct presentation written in expositional, narrative, or essay style, aimed simply to give information. Personally I prefer this type of presentation, especially when carefully prepared material is well written in simple, dignified style, and gives the same satisfying kind of information that informed parents frequently give orally in answer to their children's questions. Books of this type, designed for children of many ages, are appearing with growing frequency. Perhaps authors are trusting increasingly in the inherent interest of their subject as sufficient motivation for child readers. Besides these "direct" books, there are nature stories of many kinds, good, bad and indifferent. There are a few experiment books and books that direct various activities. A few books are presented in rhyme; and one or two in comic-strip fashion. Several more or less artificial devices of presentation are employed, examples of which appear in all types of books. It came to be a game to fit these into categories. There were, for instance, the autobiographies, in which creatures or inanimate objects told their own stories; the biographies, chiefly about animals, in which the life history, habits and sometimes ecological relationships of a species are presented through the life of a single animal, usually a young male, the boldest and most active of a family. Such stories vary from the strongly humanized type in which the animals are thinly disguised human beings to truly presented, accurate stories in which the characters behave naturally. There was the conversational presentation, in which information was conveyed through conversations among characters, human or otherwise. Among these conversational types were the "wise adult" stories and discussions in which information was given to one or more children usually by one particularly well-informed adult, sometimes a natural, everyday person, sometimes a stilted walking encyclopedia who knew all the answers. Then there were the fanciful presentations: the Alice-in-Wonderland type, where observers, changed to unnatural size and usually in charge of some supernatural character, learned about natural phenomena by imaginary observation; or where museum animals or gold nuggets or other things "came alive" and related their stories; or where a boy or a girl was transported through the power of imagination into a different time or into a different space relationship than his own. And there were what might be christened the Hip-hip-hooray type, written in the over-chatty, over sprightly style that sensationalizes the things discussed. Such devices of presentation seem to have been used more frequently and in more extreme form in older books than in the more recent ones, but in any case their importance in determining the worth of a book seems to lie

primarily in the degree to which they interfere with the accuracy and realism of the situation presented.

While I prefer the direct presentation of nature material, I concede that variety in presentation has some advantage. I repeat that the method of presentation employed seems to be important only insofar as it affects the realism of the material—the quality of being essentially true to actual facts or conditions.

What is true of method of presentation seems to be true, also, of treatment of characters or subjects. Personification—the singling out of one individual of a kind to serve as a type, humanization or anthropomorphism—the ascribing of human characteristics or behavior to things not human, for example, probably are important only to the degree to which they affect adversely the basic truth of the material. It must be added, however, that it is difficult to use such devices or to give some human characteristic such as speech to an animal not human, and still keep within the bounds of essential realism.

Choice and use of incident also affect realism and accuracy: the appropriateness and probability, the number, sequence, and relation to each other. Some stories made up of largely acceptable factual material have been so breath-takingly crowded with exciting incident that they seemed unreal.

From the standpoint of usefulness to the science teacher, choice of facts and the manner of their use are undoubtedly of prime importance. Accuracy of the most painstaking sort is of small worth unless it contributes to worthy understandings, appreciations, attitudes or skills. Thus, I came to ask: What does a given book contribute to the building of science concepts? How does it help to develop desirable scientific attitudes? I am not going to elaborate these points. An illustration or two will suffice. For example, teleology, the tendency to explain structure, function, practically anything in nature, in terms of purpose, is a common fault of children's books. I usually question those in which such expressions as "so that" or "because" appear commonly to explain structures or acts of living things. And sentimentality or prejudice such as the common attitude toward predatory animals should be largely absent from good books.

My next two criteria are matters largely of philosophy. If one believes that the nature and science experiences of young children should begin—and be largely concerned with—situations in which they can use evidence collected by their own senses as a basis of simple generalizations, good books should be closely related to the background and experience of the child by whom they are to be used. They should draw from common experiences of children data related to the concepts they present; and they should interpret truly everyday phenomena in terms their readers can understand. In addition, a good

book, I believe, should stimulate its reader to further observation, to some worthwhile activity, or to continued reading.

The presence or absence of indexes, bibliographies and glossaries, and qualities such as timeliness, uptodateness, use to which adapted, grade or age suitability, geographic appropriateness, and format, need, I believe, no elaboration. Instead, I shall spend the rest of my time discussing those ideas about books and book production I mentioned at the beginning.

My first, and perhaps chief, suggestion is for more careful checking of content and illustration before publication, by qualified persons, to eliminate weaknesses and to emphasize desirable features. Many publishers evidently give much attention to this checking, but so many books could easily have been so much better. Whether this checking is done through the author or through the publisher is immaterial, but it would seem highly desirable that more and more books meet the three standards of scientific acceptability, educational worth, and excellence as children's literature. Such checking would seem especially desirable for books written by persons without extensive scientific training in the field concerned, in books of broad scope, and in books dealing with complex subjects such as conservation of natural resources. I realize the idealism of such a suggestion, but I believe I am not alone in feeling the desirability of such procedure.

Excellent as are the illustrations in most modern books for children, I believe that higher standards could be set in books in nature study and science for accuracy, realism and general informational value. And attention to building more definite size concepts is especially desirable. Better conformity between quality of text and quality of illustration would be possible in many cases. Often an outstanding set of pictures is loosely held together by inconsequential text, and conversely, excellent text sometimes is accompanied by illustrations——and format in general—not of corresponding worth. Here a word of appreciation is due the many books where text and illustration complement each other so perfectly that their separate contributions are indistinguishable. A number of such books are the work of authors who are also illustrators or vice versa. One more point should be made here—in a number of books the format suggested material for young children, but the content was difficult reading.

That brings me to grade placement. Publishers are giving increasing attention to suggesting grade or age ranges for which particular books have been planned. Such suggestions are valuable both to reviewers and to users. Most of us recognize the impossiblity of setting up narrow or definite limits in this matter, but some qualification of the wide ranges frequently stated probably is needed. Perhaps this

qualification could best be provided by reviewers, taking into account not only reading difficulty, but such considerations as the concentration of ideas and the type and extent of background required for understanding.

As to authorship, I am unable to conclude that scientific training is in itself a guarantee of value. Authors with extensive scientific training and authors apparently without such background have written good nature books for children. The converse is also true. It seems, however, that possession of training in science favors accuracy and sometimes clarity, attention to concepts and possibly to scientific attitudes, and care to stimulate observation and further activity. But training or experience closely related to the interests and reactions of children are also important factors in successful writing in this field. I should like to digress here to mention with appreciation the growing number of books which contain on their jackets or elsewhere some pertinent information about their authors.

The problem of apparent needs for books for elementary-school-age children in various fields of science is too big to be discussed adequately in the few minutes I have left. Books on animal life in general and on mammals are numerous, but life histories of common birds are few. There is little material, on an elementary level, on snakes, lizards, salamanders, common fresh-water fishes, common groups of insects, spiders, and other invertebrates, although many of these animals are familiar parts of the environment of most children, and are the objects of considerable interest, curiosity, and sometimes prejudice. Good material, on an elementary level, on various phases of plant life, earth science and physical science exclusive of applied science, is still relatively scanty, although the number of recent books in these fields is encouraging. Stories are numerous, too, but more simple, directly presented material for reference use seems to be needed.

I should like to finish with a few remarks about reviews and reviewing. In the first place, an individual reviewer is limited by his personal background: in science, in the field of children's literature, and in the field of elementary education; by his personal preferences and experiences; and by such conditions as available time to examine books, and opportunity to check his evaluations with those of prospective users of the books, as well as with authorities whose judgment might modify or complement his. Reviewing nature and science books for children definitely is not a one-man job. That this fact is commonly recognized is attested by provision for cooperative evaluation by committees of various organizations. An interesting example is the technique set up by the California State Department of Education,

and described and accompanied by extensive lists in their 1945 publication, *Science in the Elementary School.*

Then there are the reviews. So far as I can see the outstanding characteristic of book reviews in general, and those of nature study books are no exception, seems to be diversity: in length; in specificity of comment; and in extent of critical evaluation. Back in 1929, Monroe and Hull wrote, in *School & Society*, "A Critical Review of Book Reviews," in which they concluded, after examining 548 reviews of 100 books in the field of education, that "Book reviews in general may be criticized upon at least two grounds: they are inadequate and they are non-critical. Their inadequacy lies in their failure to give sufficient information about the book. Too many reviews consist of only a few general statements describing the nature of the content and make no reference to many specific details that should be mentioned." That quotation expresses fairly well my feeling on the subject. Much the same thing could be said about selective lists.

Several years ago Dr. Carroll Lane Fenton, an author of a number of books of nature study and science for children, and a frequent critic of such books, suggested a possibility worth considering. His idea was that a board of cooperating scientists, authors, illustrators, editors, educators and others interested in the production of nature and science books for children be set up. Here books could be cooperatively examined before they were published, persons who were preparing or wished to prepare books could receive suggestions, helpful reviews and publicity measures could be sponsored, and perhaps other activities carried on that would help to improve the quality of books in the field and the possibility of the right book reaching the right child at the right time. Responsibility for improvement in quality and construction rests largely with authors and publishers. But responsibility for better choice and use of books rests chiefly with booksellers, reviewers, parents, teachers, librarians and others who guide children's reading, and, perhaps to some extent, with the children themselves. But between these two groups, the producers and the consumers, are the reviewers and selectors, whose responsibility is to work in both directions. And so, in the memorable words of one of our graduate students, "I am right back to the conclusion I started with."

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COURSES DESIRABLE FOR TRAINING TEACHERS OF HIGH SCHOOL MATHEMATICS*

AN ANALYSIS OF TEACHER PREFERENCES

G. R. THACKER AND C. B. READ
University of Wichita, Wichita, Kansas

The pre-service preparation of teachers is a topic that is coming to the fore in educational circles. An examination of the professional literature and even of literature not of professional character will bring out the importance of this problem. Authors who rank high in the various fields are asking for better teacher training. Their demands range from reorganization of present courses to the introduction of new courses in order to give those in training for the teaching profession a more usable education.

G. D. McGrath of the University of Illinois in his article in *School and Society* for January 24, 1948 states that teachers and those in training for the educational profession are persistent in their clamor that improvements be made in courses preparing teachers for schools of today. If teachers are clamoring for improvements, then a study of the opinions of these teachers as to the importance of existing courses now offered in many colleges may be helpful.

In viewing courses now offered in our colleges, the investigator is met by a vast array of different subjects in various departments. Evidently the field as a whole is too broad to be treated by a single individual. However, if the discussion is limited to the courses needed to prepare teachers of one particular subject, some analysis is possible. The problem of the present study is to attempt to determine what courses are desirable for training teachers of high school mathematics.

It would be helpful for the student who is entering college and who plans to prepare himself to become a teacher of high school mathematics (and perhaps his counselor) if he had the opinions of experienced teachers at his disposal. Teachers in the field have faced the same problems as the student. They have received their training in much the same manner as he will. They can tell what they consider important for the student to take in college to train for the teaching profession.

It was the purpose of this study to gather the opinions of experienced teachers, to analyze them, and to present the results so that students and counselors may know what training experienced teachers regard as desirable. For further information, the opinions of high school mathematics teachers are compared with the ideas held by

* Based on a thesis presented for the master's degree at the University of Wichita.

those conducting the training—i.e., heads of college mathematics departments and heads of college departments of education.

Since information was desired from educators over a large area, it was decided to use a questionnaire to gather the data. However in developing the questionnaire, interviews were held with several college instructors of mathematics and education as well as several mathematics teachers in the Wichita public high schools and the first draft was revised in view of comments received.

The questionnaire was developed for the most part in the form of a check list. It included names of courses offered in the fields of mathematics and education according to catalogues of universities and colleges in the area which was surveyed. These courses were arranged on the first two pages of the questionnaire, and columns were provided in which the teacher could place check marks denoting that in his opinion a particular course is of primary, secondary, or little or no importance in the preparation of the teacher of high school mathematics. Spaces were provided on these pages so that names of other courses in mathematics and in education could be written in. It is recognized that courses in other fields may be of importance to the teacher of mathematics, hence a third page was provided on which could be written the names of such courses which were thought to be of primary importance. Space for comments was also provided on this page.

Questionnaires were distributed over a six state area of Kansas, Nebraska, Iowa, Missouri, Oklahoma, and Colorado. Two copies were mailed to each four year college in the area, one copy to the head of the department of education and one to the head of the department of mathematics. One questionnaire was sent to the head of the department of mathematics (high school mathematics teacher) in each high school in cities of two thousand population or over according to the 1940 census. Two copies were mailed to the head of the department of mathematics in the high school when the population of the city exceeded twenty thousand on the assumption that cities of this size may have more than a single high school. The accompanying letter stressed the value of the study and gave instructions for filling in the questionnaire or check list. To encourage a greater percentage of replies, an air mail return envelope was employed. The total number of questionnaires was 714. Of this number 453 or 64 per cent were returned.

Table I gives the actual replies received on the first two pages of the check list, excluding a few miscellaneous replies not readily tabulated. Table II gives a partial listing of the courses which were written in on the third page of the questionnaire.

In an attempt to determine the relative importance of the courses,

an arbitrary weighting was used, assigning five points to a response in the column Primary, three points to a check of Secondary, and one

TABLE I. TABULATION OF REPLIES TO THE QUESTIONNAIRE

Name of Course	Importance to the Teacher of High School Mathematics											
	Primary				Secondary				Little or No			
	a	b	c	d	a	b	c	d	a	b	c	d
College Algebra	253	102	79	434	8	5	1	14	1	0	0	1
Theory of Equations	98	58	38	194	108	42	31	181	32	4	5	41
Advanced College Algebra	155	50	43	248	76	42	33	151	22	9	0	31
Solid Geometry	223	84	64	371	32	18	14	64	3	2	1	6
Analytic Geometry	165	88	48	301	85	16	26	127	9	2	2	13
Solid Analytical Geometry	34	20	19	73	114	62	38	214	84	21	13	118
College Geometry	139	65	55	259	88	29	14	131	14	7	7	28
Projective Geometry	39	5	12	56	133	60	37	230	57	32	19	108
Plane Trigonometry	247	99	69	415	13	6	8	27	2	0	0	2
Spherical Trigonometry	67	9	17	93	123	58	41	222	51	39	15	105
Differential Calculus	88	73	33	194	103	29	30	162	66	4	12	82
Integral Calculus	75	69	28	172	105	32	28	165	74	5	15	94
Advanced Calculus	11	7	6	24	79	44	35	158	139	47	28	214
Differential Equations	27	9	7	43	95	49	36	180	107	46	25	178
Vector Analysis	26	3	5	34	81	42	33	156	103	51	29	183
Survey of Mathematics	114	38	35	187	76	38	27	141	29	21	5	55
Statistics	79	32	30	141	98	50	39	187	52	20	4	76
Mathematics of Finance	74	25	18	117	116	61	39	216	38	17	11	66
History of Mathematics	124	56	28	208	89	41	34	164	34	7	8	49
Critical Review of Secondary Mathematics	110	47	37	194	68	27	22	117	17	9	5	31
Introduction to Education	107	45	35	187	87	27	30	144	43	16	7	66
History of Education	67	30	13	110	122	41	42	205	64	21	21	106
Comparative Education	25	9	2	36	109	43	32	184	73	36	33	142
Philosophy of Education	105	44	42	191	99	37	23	159	34	14	10	58
Educational Psychology	207	81	75	365	43	13	4	60	5	2	1	8
Educational Sociology	80	19	11	110	100	39	45	184	46	31	17	94
Mental Hygiene	129	38	30	197	81	38	39	158	23	15	5	43
School Curriculum	115	26	19	160	103	45	48	196	26	17	5	48
High School Methods	175	49	60	284	63	38	18	119	11	5	1	17
Methods in Teaching High School Mathematics	227	80	73	380	24	16	7	47	5	1	0	6
Supervised Teaching	198	78	71	347	43	16	7	66	12	2	3	17
Visual-Aensory Aids in Teaching	108	40	24	172	96	40	43	179	23	10	6	39
Educational Measurements	117	48	42	207	96	36	31	163	22	7	4	33
Vocational Guidance	111	32	17	160	98	40	46	184	26	18	11	55
Extracurricular Activities	65	15	14	94	111	37	38	186	53	34	24	111
Supervision of Secondary Education	37	6	7	50	102	38	34	174	85	40	28	153
Secondary School Administration	23	10	7	40	84	33	38	155	113	41	29	183
School and Community Relations	80	26	22	128	91	38	38	167	50	25	14	89

a—263 High School Teachers.
b—107 Heads of College Mathematics Departments.
c—83 Heads of College Education Departments.
d—453 Teachers and Heads of Departments.

TABLE II. COURSES IN FIELDS OTHER THAN MATHEMATICS AND EDUCATION NAMED AS OF PRIMARY IMPORTANCE TO TEACHERS

Name of Course	Times Specified			
	a	b	c	d
Physics	162	80	26	268
Chemistry	58	44	13	115
English Composition	45	19	15	79
Surveying	35	10	4	49
Astronomy	29	11	6	46
Mechanical Drawing	28	7	7	42
Speech	15	6	11	32
Philosophy, Ethics and Logic	3	16	5	24
History	10	7	7	24
Economics	6	9	8	23
Psychology	10	5	7	22
Biological Science	9	7	5	21
General Science	14	0	2	16
Sociology	2	3	11	16
Art and Art Appreciation	12	0	4	16
Foreign Languages	10	5	1	16
Bookkeeping and Accounting	9	4	2	15
Literature	5	4	5	14
Industrial Arts	8	4	1	13
Aviation and Aeronautics	12	0	1	13

a—263 High School Mathematics Teachers.
b—107 Heads of College Mathematics Departments.
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point if the course was considered of Little or no importance. It is recognized that some other weighting might have served as well. The total weighted score for each course was then divided by the total number of checks in the three columns. The actual scores thus obtained are not included in this report, however the ranks of these scores are shown in Table III. They are listed in order of importance as shown by the combined returns from the 453 educators responding.

In the replies of all responding, *College Algebra* and *Plane Trigonometry* are the only courses which were not listed as of little or no importance by at least five persons. The courses which appeared in the "Little or No" column less than ten times are *College Algebra*, *Solid Geometry*, *Plane Trigonometry*, *Educational Psychology*, and *Methods in Teaching High School Mathematics*. These were the top five courses as shown by the rankings given in Table III.

After the weighted scores were computed and the rank determined as shown in Table III, a further study of the results was undertaken. The first point of interest is that for the ten top ranking courses, there is close agreement among the three different groups responding.

Two exceptions are the listings given by college mathematics department heads to *Differential Calculus* and *Integral Calculus*. These

TABLE III. COLLEGE COURSES OF VALUE TO HIGH SCHOOL MATHEMATICS TEACHERS RANKED BY WEIGHTED REPLIES TO THE QUESTIONNAIRE

College Courses Listed	Rank Order			
	a	b	c	d
College Algebra	1	1	1	1
Plane Trigonometry	2	2	4	2
Methods in Teaching H. S. Mathematics	3	4	3	3
Solid Geometry	4	7	6	4
Educational Psychology	5	3	2	5
Supervised Teaching	6	6	5	6
Analytic Geometry	8	5	9	7
High School Methods	7	12	7	8
College Geometry	10	10	8	9
Advanced College Algebra	9	*16	10	10
Critical Review of Secondary Mathematics	11	14	11	11
Educational Measurements	13	15	12	12
Mental Hygiene	12	*20	*18	13
History of Mathematics	17	13	*19	14
Theory of Equations	*20	11	14	15
Survey of Mathematics	14	*21	13	16
Visual-Sensory Aids in Teaching	15	17	21	17
Philosophy of Education	19	19	15	18
Introduction to Education	21	18	16	19
School Curriculum	16	24	22	20
Vocational Guidance	18	22	*27	21
Differential Calculus	26	* 8	20	22
Integral Calculus	*30	* 9	23	23
Statistics	25	23	*17	24
Mathematics of Finance	22	26	25	25
School and Community Relations	24	27	24	26
Educational Sociology	23	29	29	27
History of Education	29	25	31	28
Spherical Trigonometry	27	32	28	29
Extracurricular Activities	28	30	32	30
Solid Analytical Geometry	33	28	*26	31
Projective Geometry	31	31	30	32
Supervision of Secondary Education	32	36	35	33
Comparative Education	34	33	38	34
Differential Equations	35	34	33	35
Secondary School Administration	37	35	34	36
Vector Analysis	36	38	37	37
Advanced Calculus	38	37	36	38

a—263 High School Mathematics Teachers.
b—107 Heads of College Mathematics Departments.
c—83 Heads of College Education Departments.
d—453 Teachers and Heads of Departments.
*—Ranks differing five or more from that given by (d).

courses were thought by them to be of greater importance than *High School Methods* and *Advanced College Algebra*. It is also interesting that both college mathematics and college education department heads rated *Educational Psychology* of somewhat greater importance than did high school mathematics teachers. College education department heads and high school mathematics teachers agree on the importance of *Advanced College Algebra*, whereas college mathematics department heads rated six other courses of more importance. *High School Methods* and *Educational Measurements*, both methodology courses, are included among these six.

There was close agreement in regard to the ten top ranking courses. The next question is to determine if this agreement continues on down the list. The top twenty courses in rank were next studied and it appeared that here the agreement was nearly as good as that noted for the top ten. High school mathematics teachers deemed *Vocational Guidance* of more importance than *Introduction to Education*. Heads of college mathematics departments again differed only in that they placed both *Differential Calculus* and *Integral Calculus* above several other courses. In doing this they pushed *Survey of Mathematics* and *School Curriculum* down in the list. College education department heads placed *Statistics* and *Differential Calculus* ahead of *Visual-Sensory Aids* and *School Curriculum*. As a matter of fact they placed *Statistics* in a relatively higher spot than did the college mathematics department heads or the high school mathematics teachers. Both college education and mathematics department heads placed *Theory of Equations* somewhat higher than did high school teachers of mathematics.

At the bottom of the list of thirty-eight subjects, heads of college departments of education rated *Comparative Education* as least important. Heads of college mathematics departments gave this place to *Vector Analysis*, and high school mathematics teachers put *Advanced Calculus* in the lowest spot. The three groups placed essentially the same courses as the last five on the list. High school teachers agree with the composite ranking of the 453 replies. College education department heads placed *Supervision of Secondary Education* in this group instead of *Differential Equations*. College mathematics department heads placed *Supervision of Secondary Education* in place of *Comparative Education*.

If a course showed a discrepancy of five or greater from the rank given by the combined replies, this might indicate a marked difference of opinions. High school mathematics teachers placed *Theory of Equations* in rank twenty, whereas the rank given by all teachers was fifteen for this course. High school teachers placed *Integral Calculus* at rank thirty in contrast to twenty-three for all teachers. College

mathematics department heads placed *Advanced College Algebra* at sixteen in importance instead of ten, *Mental Hygiene* twenty instead of thirteen, *Survey of Mathematics* twenty-one instead of sixteen, and *Differential and Integral Calculus* at eight and nine instead of twenty-two and twenty-three. College education department heads put *Mental Hygiene* and *History of Mathematics* at eighteen and nineteen instead of thirteen and fourteen, *Vocational Guidance* at twenty-seven instead of twenty-one, *Statistics* at seventeen instead of twenty-four, and *Solid Analytical Geometry* at twenty-six instead of thirty-one. Except for the calculus courses, these differences in rank never exceeded seven.

Whatever else may be said in regard to the indications of the replies, it seems that the opinions of both college mathematics and college education department heads have changed somewhat since Whalen made his survey some ten years ago. In a dissertation submitted in 1938 to Ohio State University in candidacy for the doctor's degree, Mr. Whalen stated that in general college professors of mathematics look upon subject matter training in mathematics as vastly more important than the professional training of the same student teacher and that professional educators differ from this opinion.

In examining the first twenty courses as ranked by college mathematics department heads it is found that nine subjects are purely of subject matter and two courses possibly of a mixed nature, that is, not purely subject matter nor purely professional. This leaves nine subjects in the field of education. It appears that college mathematics department heads feel that courses in education are as important for the teacher of high school mathematics as courses in the pure mathematics. This same general opinion seems to fit equally well the replies of college education department heads. They specify nine courses of professional and two of a mixed nature, leaving nine subject matter courses. From these results it can hardly be said that mathematics heads consider subject matter training in mathematics as vastly more important, nor that professional educators differ appreciably in their opinions from those of heads of college mathematics departments.

A study by H. T. Karnes of Louisiana which is not unlike the present study was reported in the *Mathematics Teacher* for January, 1945. Essentially the same types of educators were contacted by questionnaire in both studies. Karnes gives a list of recommended courses. Upon comparing this list with the list of courses as ranked in the present study, we find that there is a very close agreement. The courses that Karnes recommends tend to concentrate at the top of Table III. This agreement might be expected because of the similarity of the methods used in the two studies.

It might have been of value to know how many of the persons replying to the questionnaire had actually studied the courses which they rated. These facts were not included in this study and it is suggested that a separate study could be made to ascertain the importance of such facts. Because of the subjective nature of the data presented in this study, it should be pointed out that further study seems desirable in order to corroborate the findings presented here. Until such studies have been carried out, it is hoped that this report may prove of value as a guide to students and counselors in choosing courses in their teacher education programs.

Summary

In this study the opinions of high school mathematics teachers, college mathematics department heads, and college education department heads, in regard to the courses desirable for the training of teachers of high school mathematics, have been gathered and compared. In analyzing the courses which each group include in the first twenty of importance, a surprisingly strong agreement in the opinions of the three groups was discovered. Some minor discrepancies in the opinions were noted, the most outstanding being the higher rank given the *Differential and Integral Calculus* by heads of college mathematics departments as compared to the ranks given these same courses by high school mathematics teachers and heads of college departments of education.

In conclusion three important facts should be brought out. First of all, it is evident that teachers of high school mathematics need a good general education. This fact corroborates previous studies. The second and perhaps the outstanding result of this study is the fact that heads of college education departments and of college mathematics departments appear to be essentially agreed as to the amount of subject matter and professional training desirable for teachers of high school mathematics. Finally, high school mathematics teachers tend to favor professional courses to a greater extent than do the college education department heads themselves. It would appear from the second and the third conclusions that the profession as a whole is closer to an agreement as to what the professional needs are than is generally believed.

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THE QUIZ SECTION

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1. A body of mass M is split into two parts (masses m_1 and m_2) by an INTERNAL explosion which generates kinetic energy K. After explosion the parts are observed to move in the original line. Find the relative velocity of the parts.

2. Three spheres of masses m, $2m$, and $4m$ lie in a line on a smooth table. Their mutual coefficients are e. The smallest mass m is projected and strikes the mass $2m$ centrally. Find the final velocities of the masses.

3. A mass m falls freely through a height h. At this instant it begins to pull up a mass M which hangs on a string over a pulley. How high will it lift M?

4. A billiard ball is moving normally upon a cushion. It hits centrally an identical ball which stands at a distance d from the cushion. Where will they meet *again*?

5. A bullet hits a bird at the highest point of its flight, and stays imbedded in the bird. If the bird was at rest when hit where does the bird hit the ground?

WHEN IS A SCIENTIST NOT A SCIENTIST?

The answer is "When he is a teacher"; and prominent pharmaceutical educators from all over the nation concluded a 10-day conference Thursday at the University of Wisconsin at which they explored the methods of making good teachers out of scientists.

These men turned their scientific talents toward seeking new, improved, and more effective pharmacy teaching practices, with the aid of specialists in modern educational techniques. Their aim—teaching scientists how to teach.

"Better service to the public, more effective cooperation between pharmacy and medicine, and better products through better students will be the end result," according to Dr. A. H. Uhl, chairman of the conference and director of the University of Wisconsin School of Pharmacy.

The conference, now expected to be continued in future years, is the first in the field of health at which teachers have been taught to teach.

EARTH SCIENCE

An Innovation for the Secondary School Curriculum

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In presenting and recommending the subject of earth science as an innovation for the Secondary School curriculum, we have absolutely no intention of debating the merits or the demerits of any other subject. We simply desire to call attention to its many fine points, and other advantages which it might have, and to suggest its careful consideration to those who are in charge of formulating and modernizing our present high school study courses.

Neither are we here concerned with any lengthy discussion of the course outline, or the subject matter involved, as important as we feel this to be, as to do so, on account of its great scope and detail, would require so much generalization that we would be in gravedanger of missing many of the more pertinent points which we should like to make clear.

It has been stated many times, without serious question, that there is at present, perhaps, no other field of important human knowledge, concerning which there exists such abysmal ignorance, among the well educated and cultured class, than there is concerning the fundamentals of *Erdkunde*—earth knowledge. Just why this should be so, is for the present moment, beside the point.

In spite of the fact that it is one of the most basic of all sciences, and one which could contribute much to the cultural welfare of the individual in the field of intelligent and useful living, most educators, seemingly sit complacently by, wholly unaware of its fine possibilities and, therefore, little or nothing is ever done about it. Since it seems so essential to successful citizenship in a modern world, many of its proponents are now committed to a program striving to bring its real worth out into the open, the present effort on the part of the writer being in line with this idea.

Earth science is a comprehensive composite term which embraces all such subjects concerned with the physical and dynamic earth. This would include physiography, geography, meteorology, and certain phases of the geological sciences. It is, therefore, one of the broadest of subjects, and by reason of the great breadth and versatility of its content can easily be made one of the most interesting subjects in the entire school curriculum. It, too, is a subject which lends itself readily to any and every local situation, and one need not go far away from his own classroom to find many excellent examples for study. In this respect, it has for most students a great carry over

value into their actual living experience, which is always one of the best recommendations for any study.

While we feel that nothing need be said in defense of earth science, we do believe, on the other hand, that it has a great deal to recommend it. To begin with, the earth being definitely our home, in a larger sense, for the duration of our natural lifetime, we should come to know it intimately from every possible angle, just as we should want to become fully acquainted with our own locality and its physical environment. Through the study of earth science, we should arrive at an awareness that we actually know the Earth, and likewise into a realization that we are a part of it and it is a part of us, and that we should live in complete harmony with it. This in itself should make for better and more rational living experience.

Furthermore, we are indebted to the earth for all of our natural resources. In other words, for all that we are, have, or make use of. It is that vast storehouse from which we derive, either directly or indirectly, all of our food, shelter, and raiment, as well as our oil, fuel, building materials, and the raw materials for all of our industries. Is it not natural to assume, then, that anyone who goes through life without a true understanding of all this and how it came about, must be unnecessarily handicapped in his thinking and in the method of his attack on and solution of the problems of life? This alone is reason enough for the universal adoption of an elementary course in earth science in all secondary schools.

Aside from these benefits, there are other more academic reasons for which I would recommend it. As an orientation or beginning course on entering high school, there is nothing that can equal it. It has in it the elements which involve reading with understanding and expressing one's self in writing with exactness and clarity. There is enough in the historical background of the subject to create a wholesome interest in man's past. Enough mathematics is present to afford a review and a reasonable promise that it will instill in the students a realization of its practicability, for which many at that age can see no particular use.

Insofar as a necessary introduction and background for the other natural sciences is concerned, it seems most indispensable. In our studies at Joliet of the "Earth as a Planet" and its relationship to the rest of the Universe, we have an excellent preview of astronomy. In our study of the "Rocks and Materials of the Earth's Crust," we give the student a preliminary approach to the subject of chemistry. This is likewise done in our study of the "Nature of the Atmosphere and Natural Balances," which also gives us an introduction to meteorology. And finally the teaching of the dynamics of "Weathering, Erosion, Transportation, and Deposition of Earth Materials"

leads us a long way through the ramification of the physical sciences.

In as far as the secondary school curriculum is concerned, we feel that as a substitute for ninth grade (High School Freshman) general science, it has much to recommend it. A recent departmental faculty work-shop session developed the following points of interest. The question raised was, "Would *earth science* rather than *general science* better serve the needs of youth and the modern world." This brought forth numerous comments, particularly from those teachers who had formerly been employed in schools offering general science. Briefly the group felt:

1. General science as a ninth grade subject tends to be a re-hash of elementary Science.
2. General science tends to be a text-book subject.
3. Units of study in general science stress the pet interest of the author.
4. The subject matter of general science overlaps much of the material later covered in biology, physics and chemistry.
5. The content is spread too thin—general science on account of its scope tends to become too *general.*

The question of the major contributions of earth science elicited the following comment.

1. Earth science is the only science course that contacts all students since it is required of all high school freshmen. (In Joliet Township High School.)
2. Earth science introduces the student to science courses offered later in high school.
3. Earth science stimulates an interest in chemistry through simple experiments, use of apparatus, use of a few chemical symbols and equations.
4. Earth science simplifies the teaching of physics.
5. Earth science is the basis for understanding geography and interpreting history.
6. Earth science offers a contribution to English and mathematics.
7. Earth science offers an opportunity to teach use of statistics and graphing.
8. Earth science classes are taught how to set up reports. (Of significant value to other classes.)
9. Earth science encourages the questioning "why?" (Scientific thinking.)
10. Earth science develops interest in leisure-time activities.
11. Earth science develops an interest in nature—environment.
12. Earth science teaches *living* on earth not teaching to live.
13. Earth science adds through study of new terms, an appreciation of languages.

14. Earth science adds to enriched appreciation of world in which we live.

15. It is a stimulus to "rationalized living" and confines our work to things which are tangible.

And finally we have arrived at the question of "Why is not more earth science being taught in the secondary schools of America?" The answer to this is complex and has many angles. I believe it was Huxley who once wrote words to the effect, that, "the ingenuity of human invention has ever been paralleled by the tenacity with which original forms have been adhered to." Nowhere, perhaps, has this truism been better exemplified, than in the make up of the traditional secondary school curriculum.

This is especially notable, since such recognized inertia among those who control and formulate our courses of study, is contrary to many of the ideas of modernity to which they themselves (as individuals) would most certainly heartily subscribe. In few other fields of human endeavor do we find so little consistancy and so great impediments to progress. This is almost equally true in both our small and our larger systems alike.

While our farmers have graduated from use of the "cradle," to the reaper and modern combine; and our transportation systems have improved from the ox-cart to modern streamliners, automobiles and air planes—and, the same could be said of music and art—the core of our traditional secondary school curriculum has for nearly half a century made scarcely any recognizable or genuine change or progress.

This casual statement of facts, is not intended as an indictment of any person or system, but simply a reiteration of common knowledge which we hear on every hand whenever educators get together. The question is, why is so little ever done about it? This is due, perhaps, to a combination of circumstances building up over long periods of time. It is well known that when trends are once established, and events begin to drift in certain directions, it is sometimes very difficult to bring about a reversal. This is about all that can be said on the matter here without going into a lengthy discourse, which at the present would be of small avail.

We do not for a moment wish to leave the impression that there might not be difficulties connected with the introduction of the study of earth science in every school in the land, for this would not be actually the case. For the most successful methods of presentation of the subject some field trips, at least, would be desirable,which, it is obvious, in certain situations might encounter difficulty. (Pupil transportation is always a big problem.) Likewise, for apparently the same reason that so little earth science is being taught in our public schools today, is the impossibility of securing an adequately

trained teaching staff for presenting the subject, were its adoption to become widespread immediately. This, no doubt, might also become another serious drawback.

It has been our intention in the present paper to stimulate our thinking along certain lines where progress might actually be made, without too great disruption of the current status quo. We trust that no one will feel that the writer believes this to be the final word on the subject. Course outlines, objectives and teaching techniques are all questions upon which we might well elaborate, had we the time and space to do so, but which must now of necessity be left for some future consideration.

PROGRAM ANNOUNCED FOR PACIFIC INDUSTRIAL CONFERENCES

Tentative programming of the multitudinous events at this year's Pacific Chemical Exposition and Pacific Industrial Conferences, to be held in San Francisco's Civic Auditorium November 1 through 5, was completed this week, announces Marcus W. Hinson, Exposition Manager. Highlights of the five-day industrial chemical gathering, taken from the detailed program soon to be issued, are: talks and panel discussions under eleven separate scientific groupings; more than one hundred commercial exhibits; a group of special exhibits; and continuous industrial motion pictures.

Opening the Pacific Industrial Conferences—to run concurrently with the Exposition—will be a symposium on Tuesday morning, November 1, on "Regional Requirements for Chemicals" under auspices of the Western Chemical Market Research Group. Rounding out events of the first day will be an afternoon conference and panel discussion on "Export Markets for Western Chemicals" led by the World Trade Section of the San Francisco Chamber of Commerce.

The remaining groups under which separate panel discussions will be held for the balance of the week are as follows: Petroleum Division, American Chemical Society (California Section), and American Institute of Mining Engineers; American Institute of Chemical Engineers (Northern California Section); Northern California Instrument Association; Pacific Insecticide Institute; Protective Coatings Group; Agricultural and Food Chemistry Division, American Chemical Society (California Section); Forest Products Research Society (Northern California Section); Northern California Rubber Group and Society of the Plastics Industry (San Francisco Section); and Pacific Association of Chemistry Teachers.

NEW ENCYCLOPAEDIA BRITANNICA FILMS

The conservation films—*The Forest Grows*, *The Forest Produces*, and *Forest Conservation*—were produced by the Conservation Foundation and the New York Zoological Society, producers of The Living Earth Series of films distributed by EBF since last year. Like the former, the new forest films are each one reel long in full color and discuss graphically the immense importance of Americas forests both to industry and our food supply. They were made under the direction of Fairfield Osborn, author of "This Plundered Planet" and George Brewer, producer of The Living Earth films.

DICE PROBABILITIES AND THE GAME OF "CRAPS"

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Rattling resonantly down the ages, dice games have provided mankind with one of its favorite forms of self-invited risk. The origin of this pastime is shrouded in the mists of Oriental antiquity, but there is abounding proof of its existence for several thousand years—first, in the Far and Near East, and later in the lands of Western civilization. Archeologists and historians have found evidences of crude dice in the tombs of China and Egypt, and the records of the Greek and Roman eras show that the practice had become both popular and polished by that time.

Always of widespread interest, dice games are probably at the peak of their popularity today—the outgrowth of the wartime introduction of millions of young men to the "galloping dominoes." Though gambling is considered a diversion from routine pursuits, paradoxically there is an inherent monotony in dice games. Lengthy participation, a habit of dice devotees, tends to induce considerable dullness. As a result, many variations have been invented over the years in order to make dice-throwing more exciting. However, the underlying principles of virtually all dice games, past and present, seldom differ.

The standard game of dice is one known in the vernacular as "craps." According to philological theory, that somewhat undignified name came into use after continual mispronunciation of "crabs" —a word once uttered frequently to bemoan a lack of luck. In recent years, there has been a tendency to shorten the word to "crap."

"Craps" or "crap," the game is a relatively uncomplicated one, both in its rules and in its style of play. Of almost mechanical simplicity, it is played in precisely the same way wherever the game is known, whether it be an elegant gambling casino catering to the wealthy or on a street corner with nickels and dimes as the stakes and a look-out to warn against the cop on the beat.

It is undoubtedly the exceptional simplicity of the game that gives it such wide appeal—that and the rapid rate of play during which every single toss, with its possibilities of "win or lose," is freighted with drama.

In "craps," the medium of action is a pair of dice—each die being a cube, each face bearing a number from 1 to 6. The technique is for the player—known variously as the "shooter" or "tosser"—to shake the dice in the loosely-cupped fingers of one hand and to propel them

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in such a manner as to make sure they roll over several times.

Sometimes "gambling house rules" require that the dice actually bounce off a wall or specially-constructed side of a gaming table. The thorough rolling is intended to dispel any suspicion that the dice are cunningly controlled by sliding them to produce a desired number—a feat quite feasible when the fingers are properly trained.

After each toss of the dice, the sum of the numbers or "pips" appearing on the top side of each die determines whether the shooter wins or loses. That, of course, depends on certain fixed rules. If a player's very first throw brings a sum of 2 or 3 or 12, he automatically loses his wager but retains the dice for further play. If the very first throw brings a sum of 7 or 11, he automatically wins the wager as well as the right to continue. However, if the first throw registers any other number, that number is called the "point," and the player must keep tossing until he either repeats the "point," thereby winning, or makes a 7, which means that the particular bet is lost. In the latter case the dice must be surrendered to the next player.

Since, on the first throw, 2 or 3 or 12 automatically loses, and a 7 or 11 automatically wins, none of these numbers can possibly become a point for which the player must continue to shoot.

On the other hand, the only one of these numbers which has any significance after the first throw is the 7. Though the 7 is a winning number on the first toss, it is the player's constant nemesis when he is shooting for a point. Thus, 7 is the most fateful of all the numbers on the dice—symbolizing success on the first toss but failure when it occurs during the attempt to make the point.

The operator of a dice game never throws the dice; he knows better.

First, consider the chance of making any total with two dice on a single toss. Since there are six faces on each die, a total can be ob-

PROBABILITIES FOR TOTALS ON TWO DICE

Total	Probability of Occurrence	Odds Against Making Total in Single Toss
2	1 chance in 36	35 to 1
3	2 chances in 36	17 to 1
4	3 chances in 36	11 to 1
5	4 chances in 36	8 to 1
6	5 chances in 36	31 to 5
7	6 chances in 36	5 to 1
8	5 chances in 36	31 to 5
9	4 chances in 36	8 to 1
10	3 chances in 36	11 to 1
11	2 chances in 36	17 to 1
12	1 chance in 36	35 to 1

tained by adding any face on one die to any face on the second die—36 ways in all. The frequency of occurrence and the mathematical odds against making the respective totals are given in the table above.

These probabilities can be verified by using one red die and one blue die to determine the number of ways in which each total occurs.

What are the prospects in a standard game of "craps"?

In 1980 win or lose decisions, by *a priori probability*, the tosser should make the expected number of wins and losses shown in the table below. The breakdown is presented by considering the kinds of first tosses possible and the results of the individual wagers.

EXPECTED RESULTS OF 1980 DICE WAGERS BY THE TOSSER

First Toss	Number of Occurrences	Wagers Tosser Will Win	Wagers Tosser Will Lose
2	55	0	55
3	110	0	110
4	165	55	110
5	220	88	132
6	275	125	150
7	330	330	0
8	275	125	150
9	220	88	132
10	165	55	110
11	110	110	0
12	55	0	55
Totals	1980	976	1004

The odds against the dice-tosser are always 251 to 244, regardless of whether he plays the game in a gambling house or with his friends. These odds are equivalent to an advantage of 1½% (actually 1.414%) in favor of the operator of the game or in favor of the players who do not throw the dice in a friendly game.

This means that if a player continues to toss for a long period of time, the result of all his individual wins and losses is that he loses 1½% of the total amount he pushes forward on the betting table, including the addition of the rebetting of the original money many times. While this may not appear to be much of a disadvantage, compare it with the percentage paid as annual interest on deposits in banks. Every minute the operator wins a percentage as high as one-year interest rates.

The data presented above are based on the assumption that the game is "honest" and the dice are "legitimate," but this assumption is not always safe. Sometimes gambling houses use dice which are so constructed as to toss certain numbers more often than others, for example, 2 and 3 and 12—the "craps" shots which automatically lose on the first throw.

Some houses have special tables, wired so that they can be magnetized. The dice contain metal, and when the operator puts the current on so that the table top acts as a magnet, the dice throw a 7. This type of game is a gambling trick known as "seven them out." After a tosser has made a point on the first toss—and the chances are 24 in 36 that he will—the operator throws a switch or steps on a button or wire to send the current through the plate embedded in the table top. The next toss is a 7 which means that the player losses. Such an event is also referred to as "two rolls and no coffee." This device is expensive and is used only by large establishments, and even then only when there is plenty of money on the betting board.

Cheating is not confined to the fancy places, however. It also occurs in games on make-shift tables and the ubiquitous horse blanket which is often used for dice playing. (Beware of gamblers using a horse blanket, for at least one of the players will be an expert who has spent many hours each day practicing dice-throwing so that he knows exactly how to hold the dice and how to toss them in order to hit certain totals.)

As a matter of fact, it is easier to exchange "phoney" dice for legitimate ones in the small dice games than in the gambling house. The horse-blanket game is ideal for making dice switches.

Phoney dice which are often used are those which toss only 7 and 11. One die has only 2's and 6's on it while the other die has only 5's.

Other illegitimate dice show *only* points—that is, 4, 5, 6, 8, 9, 10—and a single first-toss winner, the 11. One die has only 1's, 5's, and 6's; the other has 3's, 4's, and 5's. Such phoney dice which never throw 2, 3, 12, or 7 are generally called "tops and bottoms."

Clever manipulators can interchange these phoney dice whenever they choose. Often two or three or even four sharpers band together for switching purposes. Not only is switching relatively easy under such circumstances, but there is also little chance of being caught. If a player suspects the dice are phoney and reaches for them, one of the sharpers blocks him while another looks at the dice and assures the suspicious player that the dice are all right. Unaware that the sharpers are working together, the victim continues to be cheated.

Another trick is to use "loaded" dice. The material below the holes or pips of certain numbers is removed and replaced by small special weights. These "loads" cause specific numbers to turn up more frequently than they would if the dice had not been altered.

Most gamblers carry the specially-constructed dice with them, especially the pair which always throws 7 or 11, and the pair which never throws 2, 3, 12, or 7. While tossing the dice, the sharper replaces the regular pair with such illegitimate ones for several throws, winning five or six successive wagers. Then he replaces the phoney

dice with the legitimate dice to avoid being suspected.

The honest die is a perfect cube of homogeneous material, the edges of which are perfectly straight and the corners even. Sometimes the edges and corners are rounded off so that more freedom of movement is permitted. However, sharpers often round some edges and corners while leaving others relatively sharp. Such tampering gives the dice a bias—that is, permits certain numbers to turn up more frequently than would result in an honest set of tosses with untampered dice.

A discussion of experiments made with tampered (biased) dice is given in *You Can't Win* (*Facts and Fallacies about Gambling*).

Many players (especially sharpers) pyramid their wagers while tossing the dice, in an attempt to win a huge amount of money. After winning a $1 wager, the player bets $2; after another win, he lets the $4 "ride"; then on to $8, and $16, and so on. Sharpers who use phoney dice often win six or seven wagers in a row, but the average player with legitimate dice rarely wins under this system, because the odds against winning a long string of consecutive wagers are tremendous.

As may be noted in the table below, which shows the chances of making a string of straight wins, the probability of winning eight consecutive wagers in any manner whatever in a dice game is one chance in 287. The probability of nine straight "passes" is one chance in 582, and for ten successive "passes" there is one chance in 1181.

If you consider winning wagers only by tossing 7 or 11 on the first throw, the odds against being successful are multiplied many times. For example, the odds are 168,150 to 1 against making eight "naturals"—7 or 11—in a row; 756,680 to 1 against nine consecutive "naturals"; and more than three million to one against a string of ten.

PROBABILITIES OF CONSECUTIVE WINNING PLAYS

Number of Consecutive Wins	By 7 or 11 or Making Point	By 7 or 11 Only
1	244 chances in 495	2 chances in 9
2	24 chances in 100	1 chance in 20
3	3 chances in 25	1 chance in 91
4	1 chance in 17	1 chance in 410
5	1 chance in 34	1 chance in 1,845
6	1 chance in 70	1 chance in 8,304
7	1 chance in 141	1 chance in 37,367
8	1 chance in 287	1 chance in 168,151
9	1 chance in 582	1 chance in 756,681
10	1 chance in 1181	1 chance in 3,405,063

Of the several variations of dice games most widely played by dice enthusiasts, *Chuck-a-Luck* has the greatest attraction even though it

enables the operator of an "honest" game to take continuously about 8% of all the money being wagered by the players.

Double or Nothing, another popular game, gives the operator an 11% "take," while a game called *Over Seven, Under Seven, Exactly Seven* is even more unfair, giving the operator 28% of all the money wagered.

When phoney dice and sharpers' tricks are introduced into these games, there is no way to compute the mathematical probabilities or the percentage "take." The "professional" gamblers really take all of the players' money under those circumstances.

Thus, there are always two things against the player, just like a double-barreled shotgun—the mathematical probabilities and the sharpers' tricks—and most of the time the "professionals" get you with both barrels.

You Can't Win.

430,000 COLLEGE DEGREES GRANTED DURING ACADEMIC YEAR JUST ENDED

Federal Security Administrator Oscar R. Ewing announced today that colleges and universities throughout the United States conferred approximately 430,000 degrees during the year ending June 30, 1949—an all-time high. This estimate by the Office of Education, Federal Security Agency, is based upon returns from about 1,000 of the Nation's 1,200 degree-granting institutions, Administrator Ewing explained.

Earl James McGrath, U. S. Commissioner of Education said of the survey findings today, "This year's estimated total of 430,000 college degrees tops last year's previous high record of 319,000 and practically doubles the number in the pre-war peak year of 1939–40. The total, includes 375,000 bachelor's or first professional degrees, and 55,000 advanced degrees, either master's or doctor's. Thirty-eight percent more bachelor's or first professional degrees were granted in 1948–49 than in 1947–48. The number of doctor's degrees rose 29 percent over the preceding year, and the number of master's degrees 20 percent."

SECOND LARGEST TELESCOPE AHEAD OF SCHEDULE

The second largest telescope in the world, being built at the University of California's Lick Observatory, will go into operation two years ahead of schedule. Purchase of a 120-inch mirror cast in 1933 to test the design for the giant 200-inch Palomar telescope makes this possible.

Lick's new 120-inch mirror is now in a warehouse in San Jose near here, after a 400-mile truck trip from Pasadena. It will remain in the warehouse until the dome at Lick Observatory is completed. The 120-inch mirror was purchased from the California Institute of Technology, but has never been used because of a change in test procedure there.

The original design for the Lick telescope called for the conventional solid disk mirror. Recent tests at Palomar, proving beyond doubt the practicality of the new 200-inch design, led University of California astronomers to purchase the 120-inch test mirror of the same design.

GUIDING PRINCIPLES IN CURRICULUM MAKING FOR SCIENCE IN THE ELEMENTARY SCHOOL

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In an effort to ascertain a proper basic orientation to the task of developing a program in science for an elementary school, an examination was made of a wide selection of recent literature on curriculum making. The writings (books and articles) of authorities in the curriculum field were examined in order to derive a list of guiding principles for curriculum making in elementary school science.* The literature in curriculum making pertinent to this problem fell into the following four categories: *education in general, elementary education in general, science in general,* and *science in the elementary school.* The principles chosen from these categories were those which particularly affect curriculum making in elementary school science.

Principles of curriculum making in *education in general* which affect curriculum making in elementary school science are:

1. *Education is concerned with the development of the learner.* Education should not only teach the individual how to make a living, but how to live. The individual's development should result in self-realization, or a manifestation of mental curiosity; health knowledge and habits for each person, his dependents and community; sports and pastimes and other recreation; as well as intellectual and aesthetic interests.

Each person should realize that the healthy individual finds success more readily than others. Scientific knowledge will enable those who are educated to entertain no doubts regarding the functions of the human body and mind. Superstition and erroneous beliefs have no place in the life of one who is educated.

2. *Education is concerned with home, family, and community life.* Education should include instruction in the solution of problems growing out of home and family life. The largest problems of this phase of living which are directly related to science are food and diet, clothing, and shelter.

The homemaker should have a knowledge of diet in foods and fashion in clothing. Protection and maintenance of health, care of the sick, cooking, and consumer purchasing are his reponsibility. Routine child care and the selection of play equipment are also important. The school has much of the responsibility of instruction in homemaking since labor-saving devices have removed many of the circumstances

* Lewis R. Fisher, *Selected Approaches to Curriculum Making in Elementary School Science.* (Unpublished Doctor's Dissertation.) Austin: University of Texas, 1948.

which permitted teaching children cooking, sewing, production, preservation, laundering, and other activities in the home.

3. *Education is concerned with economic demands.* Scientific studies homemaking, mathematical, agricultural and industrial studies in the schools give daily instruction in the occupational activities. The school should initiate the discovery of abilities and interests and provide for their development in every pupil.

The elements composing our natural resources, such as raw materials and climate, as well as the handling of tools and machinery, should be a part of the curriculum which aims to make contribution to economic improvement.

Consumer education is needed for wiser purchasing and consumption of food. The consumer should know that dietary needs vary with types of foods and persons. Education will enable the consumer to see that clothing meets the purposes for which it is worn—for health, protection, and appearance.

A sound national economy will be supported by health education. Medical science, public health improvement, and personal health have their greatest economic value in lengthening the span of human life. Education is a means of lowering the mental and physical strain on the human body which is ever present in a highly industrialized environment.

4. *Education is concerned with civic and social duties.* Scientific methods will enable one to use critical judgment through the application of openmindedness, observation, reflection, and comparison before reaching conclusions. Wise deductions in civic affairs can prevent the individual from becoming the victim of propaganda.

The informed person is aware that scientific discoveries are valuable only as they are introduced and used with caution until they are proved an asset to society. Scientific advancement makes a greater contribution to general welfare when its benefits are made available to all of society.

Principles in curriculum making in *elementary education in general* which affect curriculum making in elementary school science are:

5. *Children should be educated for adequate living in their day to day experiences.* Giving the child a foundation for the solution of problems which have their value solely on the adult level cannot produce satisfactory child-development. Education is not merely a business of getting ready to live happily and fruitfully in the future, it is the process which aids in living fruitfully from birth to death. Education is life itself and not just a preparation for future living. The elementary school should offer a combination of experiences which will make life meaningful to the child. The mastery of facts is valuable only as facts are used in interpretive understanding, critical thinking, and

changed behavior. The school should no longer be removed from the outside world, but the problems of the child's immediate life should be brought into the classroom for solution.

6. *The elementary school should provide experiences which will enable the child to effect desirable adjustments to his environment.* The opportunity is given the school to select and direct the experiences of the child during the majority of his waking hours. The elementary school child should be afforded real life situations which will promote the ability to do creative thinking and problem solving. Yet these experiences must allow for individual pupil differences; meet the needs, purposes, and interests of the child; and permit him to feel the thrill of success and achievement. Experiences can be planned and directed so as to promote the development of an integrated personality, thereby achieving the education of the "whole child."

7. *The elementary school should function in the child's development of social understandings and responsibility.* A democratic environment in the school can break down prejudices and destroy ideas of racial superiority. The well planned elementary school curriculum can disperse information conducive to an appreciation of the interdependence of all peoples. Making community projects a vital part of school activities will increase civic interest and reponsibility. Developing the capacity for social living in the school and community and the development of good citizenship can become reciprocals.

Social understandings and responsibilities are attained as the results of emotionalized experiences, observation, and participation. For a social studies concept to be complete scientific interpretations must be made and considered. Every science activity has its social aspect.

8. *The elementary school should make provision for satisfying the needs and interests of the child.* Because physical, mental, and experiential progress occur only through a sense of need or fail to progress for a lack of need, it is necessary that the elementary school lay in the child the foundation for the ultimate understanding of all basic human needs. A child's curiosity reveals his need for intellectual knowledge. He should receive a reasoned orientation to his physical environment and its myriad physical phenomena. He needs to develop belief in himself, an integrated personality, and a character to guide the initiation and regulation of his own behavior. One of the child's greatest needs is for physical development. He needs health knowledge, health habits, and instruction in play, exercise and relaxation.

Principles in curriculum making in *science in general* which affect curriculum making in elementary school science are:

9. *The social implications of science should be recognized.* Scientific progress constantly raises social standards by providing improve-

ments in ways of living and by giving proof that there are better ways of living. Many world-wide problems are of a scientific nature bearing social implications. All nations become a brotherhood in their mutual struggle against scarcity, disease, pests, adverse climates, and other enemies of human well-being.

10. *Science should be taught as a means of insuring the democratic way of life.* Since science is largely responsible for our complex mode of living today, it is thus indirectly responsible for many of our problems of modern society and human relationships. The scientific discoveries and inventions of man as he struggled against his environment have had a great deal to do with the development of these problems. What then can science offer in providing solutions? A close parallel between scientific problem solving and the democratic way of living is most desirable when meeting problems of a personal and social nature. Teachers should strive to inculcate in their pupils desirable scientific attitudes, techniques of scientific procedure, and scientific knowledge. Science functioning for the promotion of democracy will stress the use of scientific discovery for the benefit of all humanity.

11. *Science should function as a means of teaching methods of attacking the problems in all of life's difficulties.* In most of life's experiences there arise problems, the most advantageous solution of which depend almost entirely upon the ingenuity, abilities, and skills of the individual. One of the best assurances of achieving problem-solving abilities is the conscious effort to create practice in problem-solving situations. Well planned activities providing repeated training for habits conducive to problem-solving are the best foundation for desired growth in this respect. Every effort should be made to encourage a carry-over into experiences outside of the classroom.

12. *Science should function in the development of the emotionalized attitudes which contribute to desirable behavior.* Mental dispositions acquired from a study of science are commonly known as scientific attitudes. When a pupil holds an emotionalized attitude toward scientific thinking, there is a natural tendency to apply scientific method to the solution of problems of all types. The development of scientific attitudes is not only a goal within itself, but it aids in the realization of other objectives in the field. The true value of scientific attitudes is realized when they destroy snap judgments, short-sightedness, bigotry, ignorance, and intolerance in American youngsters.

13. *Science should develop interpretive understandings conducive to reflective thinking.* Science has been compared to a road map which makes no decisions for us; but clearly shows the way; and enables us to make our own correct decisions. It aids us in weighing choices and helps us to see the choice which will benefit us most. Mastering facts and applying them to practical situations enhance one's ability to

make generalizations and understand principles. Science taught as a way of thinking stimulates the desire for perfection in scientific inquiry, accurate observations, and testing knowledge rather than the acquisition of mere factual information.

14. *Science contributes to the education of the consumer.* It is a common belief that any phase of science which is important enough to be given a place in the school curriculum has value in the education of the consumer. Numerous features of true science have important practical applications. Most goods in production, processing or distribution have to do with some field of science. A wide general knowledge which reveals a varied assortment of informational sources, and learning to use keen critical judgment are probably the most valuable benefits to be derived from consumer science.

Principles in curriculum making in *science in the elementary school* are:

15. *The elementary school science program should be constructed of materials drawn from the child's own environment.* The most valuable subject matter for use in formulating the elementary science program is that which will form a background or framework for larger experiences that come with added years of living.

16. *The elementary science curriculum should be based on problems of living and social needs.* Fundamental to establishing proper social values is a functional knowledge of the inter-relationship of one living thing to another living thing, and of each living thing to its phsysical environment. The social aspects of science content would embrace topics on health, safety, conservation, and economics. Great social import is found in a study of health improvement in the nation and over the world.

17. *The elementary school science program should be organized on the basis of both children's interests and the values held by the teacher as objectives.* The needs and interests of the elementary school child should be given more adequate considerations. However, the science curriculum cannot be built on pupil interests alone. The science curriculum should be the outcome of teacher-pupil planning in the sense that the materials used hold the interest of the pupils, yet achieve the objectives set up by the teacher. The clever and alert teacher can guide the interests of children into profitable learning situations. Allowing interest to completely control the character of a science program, however, is a debatable procedure. As children's interests and comprehension broaden, materials of social significance can be introduced.

18. *Science should be taught in the elementary school as a means of developing a special understanding of "science as a way of thinking."* Subject matter, and topics or problems, or materials should be chosen because they help the child meet the various issues of life rather than

because they happen to be in textbooks. Nevertheless, content should not be minimized; it is a means toward an end. Primarily, the science curriculum should promote scientific thinking. Science should not be taught in the elementary school for "science's sake." The child should be taught scientific thinking so that he can begin to realize the interaction of the individual with his environment.

19. *General procedures should allow for the growth of broadening conceptions derived from a series of experiences.* The presentation of fundamental science concepts depends almost entirely upon the experiences of the child. Some basic points in the choice of experiences upon which conceptions can be built are (1) that the experiences appeal to the child, (2) that the child should be allowed to participate in planning and carrying out the experiences, and (3) that the experiences should be used as points of departure for further learning. Often, through a series of experiences, the pupil can gradually reach a climax of understandings.

20. *The reasons and purposes underlying methods of science teaching should be the outgrowth of a philosophy of education.* Needless to say, the varied philosophies of different schools will cause variation in science objectives. It is obvious that the school which proposes to make scientists of its pupils or to prepare its pupils for college entrance, or to enable the pupils to take up a vocation will develop an entirely different curriculum in science than the school which specifies that elementary school science should be liberal and cultural. The philosophy of a given school determines the objectives of the science program, and the objectives in turn determine teaching procedures. In the final analysis, methods are dependent upon educational philosophy.

21. *Procedures should be a means of helping the child appreciate and use scientific method in meeting the problems of life.* It is the responsibility of the school to give its clientele the training that assists it in interpreting environmental problems. Science, then, in this capacity, should develop in the child a scientific attitude which will enable him to transfer the benefits of his learning to broader use in all problems of life. The outcomes of scientific problem-solving should be resourcefulness, adaptability, and self-criticism.

22. *Methods employed for presentation of the elementary science program should embrace specific techniques which will allow active and purposeful pupil participation in activities.* It is an old adage in the teaching profession that "we learn by doing." Our modern interpretation of the idea could be simply expressed in the one word, *activity*. Purposeful activity is not just "busy work"; it is participation. Experiences entailing problem-solving situations which are handled by techniques conducive to critical thinking should be the largest phase

of the elementary school science curriculum. The following suggestions are made concerning pupil science experiences: Experimenting should have motivation, thoughtful planning, and intelligent direction and application on the part of both pupil and teacher. Reading activities should be done for discovery with a purpose in mind—used to help solve problems and check conclusions. Observation as an experience for the promotion of scientific thinking should be based on accuracy and thoroughness. Identification should be an incidental outcome of observation rather than a primary purpose. Much time should be spent planning excursions and making deductions from such experiences. Though collecting is primarily valuable for the purpose of motivation and comparison, it will often incidentally inspire observation for the purpose of identifying and classifying various items. Construction as an activity of the science curriculum is most useful as it consists of assembling objects which illustrate science principles or clarify problems to be solved. By far, the most important function of discussion as a science activity is to facilitate the exchange of ideas between both teacher and pupil, and pupil and pupil. Used as a culminating activity it can serve in evaluation, constructive criticism, making deductions, and to encourage creative thinking.

23. *Worthwhile appreciations should emerge from the study of science.* Appreciations, like attitudes, are developed from an emotional foundation. To realize fully the worth of science is not merely to know the value of cold factual applications of scientific principles to modern living. All the significant experiences of life produce complex feelings.

Types and depths of appreciations will vary with the methods used for attaining them. Like attitudes, appreciations are more readily obtainable when they are sought through planned classroom procedures. Becoming familiar with the advantages of using the scientific method will instill confidence in it as a means of solving a number of life's problems.

24. *The elementary school teacher should have some form of special preparation for teaching science.* It is not necessary that a teacher be a scientist in order to teach science properly in the elementary school. Strictly technical science information is not a basic requirement for good science teaching at the elementary level. A knowledge of high school general science and biology together with the experimental attitude and aptitude for successfully guiding children in problem solving are good equipment for the beginning science teacher.

Nevertheless, authorities agree that elementary-school teachers need special preparation in college for the business of science teaching. The foundation for the potential science teacher's work can best be laid by a college survey course in physical and natural sciences

planned to meet the specific needs of the elementary teacher. For the teacher who cannot benefit by such a college couse, there are various methods of self-preparation. Many good courses of study or handbooks are available. Reading widely in the field of science will also be advantageous. The science teacher can also enlarge her own experience through observation and experimentation. She can learn to use the school community and environment to the fullest extent.

25. *Science should be taught so as to give the pupil a broader conception of truth.* One of the fundamental outcomes of the study of science is the realization than man's conception of truth changes. Precaution should be taken to prevent the child's development of the idea that science content is true for all times. Because authorities believed a fact to be true ten or twenty years ago does not prove that it is true now. Our greatest instance of the unreliability of apparently proved theories is found in the evolution of man's conception of the shape of the earth. In teaching this phase of science emphasis can be placed upon the importance of experimentation and observation.

ON THE USE OF SIMPLE TERMS

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A plumber wired the Bureau of Standards and asked whether hydrochloric acid could be used for cleaning out some pipes. The answer came back, "Uncertainties of reactive processes make use of hydrochloric acid highly undesirable." The plumber wrote back thanking the Bureau for the advice, saying that he would use the hydrochloric acid. The Bureau wired him again, "Regrettable decision, we cannot assume responsibility for the production of toxic and noxious residue with hydrochloric acid and suggest you use an alternate procedure."

The plumber was happy again that the Bureau was in agreement with his idea and so informed them. Then the Bureau wrote "Don't use hydrochloric acid. It eats hell out of the pipes."

(Source Unknown)

NOVEMBER 9 OPENING DATE FOR GEORGE EASTMAN HOUSE

George Eastman House will be opened to the public on November 9, Dr. C. E. Kenneth Mees, president of the photographic center in Rochester, N. Y. announced today.

Plans for the opening include ceremonies to be held in the Eastman Theater and at the house November 9. Distinguished visitors from the world of photography and related arts and sciences are expected to attend.

The collections of historical photographic equipment and materials are now "substantially ready for installation," Oscar N. Solbert, director of the photo center, said. These exhibits will be displayed in specially designed cases in the main house. The cases were delivered this month and are now being assembled.

NEW EMPHASES IN MATHEMATICAL EDUCATION, WITH REFERENCES TO RECENT LITERATURE

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Shortly after the close of World War II some apprehension was felt as to the future status of secondary mathematics in this country. The erstwhile high esteem in which it had been held briefly by the general public seemingly wavered, and in some quarters a general reversion to an earlier state of unpopularity was freely predicted. The expected loss of prestige, however, did not materialize, and it is fair to say that mathematical education today has assumed a new lease on life.

Ample evidence of this renewed vigor may be found in a number of distinct trends, or new emphases, which have become clearly discernible during the last three or four years, and which bid fair to exert a significant influence for the next decade or longer. These current trends may be succintly stated as follows: (1) teaching for meaning and understanding; (2) effective guidance of pupils; (3) increased use of audio-visual aids; (4) greater use of enrichment materials. It need hardly be pointed out that these new emphases are more or less interrelated, and that effective practice or improvement in any one area is almost sure to affect one or more of the remaining ones.

The purpose of this paper is to comment briefly on these important trends and to present certain source materials in connection with them.

1. MEANING AND UNDERSTANDING IN MATHEMATICS

To be sure, the so-called "meaning theory," in contrast to mechanistic or rote learning, is not new in the field of elementary arithmetic. Teaching arithmetic for understanding is no longer a battle-cry, but rather an established practice, thanks to the excellent work of W. Brownell, J. T. Johnson, R. L. Morton, H. Van Engen, H. G. Wheat and many others. Unfortunately, however, the term "meaning" has been interpreted in various ways: Brownell distinguishes between meaning *for* and meaning *of* arithmetic; Johnson distinguishes between *structural* meaning (symbols), *functional* meaning (social use), and *operational* meaning (rationalization of processes); and Wheat argues that an understanding of the nature of number must precede rather than follow the understanding of quantitative social situations. Despite this apparent obfuscation, it would seem that there is merit in all these viewpoints; they are simply various facets of a major aspect of human behavior, namely, ***relational thinking***.

Relational thinking deals with the purely logical content of experience; it is the very substance of mathematics. This applies to elementary arithmetic, to high school algebra and geometry, and to collegiate and graduate mathematics with equal force. Relational thinking involves abstraction, generalization, symbolism, and quantitative thinking. It is basic to human behavior, but it requires cultivation. Moreover, it is involved in all sorts of social, economic and personal situations. As Mursell, in his recent text, *Developmental Teaching*, very aptly puts it, "for everybody, the heart of the mathematics program consists in coming to grips, through understanding, with mathematical relationships and concepts." In short, there can be no temporizing: genuine understanding in mathematics involves the entire personality; it is a continuous process, subject to growth; it is an emergent phenomenon, manifesting increasing precision and refinement as it develops. Needless to state, not all individuals can attain the same level or degree of understanding; but whatever degree is reached, such meaning or insight is a very different outcome from mechanically performed skills or memorized verbal responses. This is the crux of the emphasis on teaching for "meaning and understanding" in all mathematics, and, in view of its extreme significance, we append a partial bibliography of relevant literature. The first group contains general references.

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Breslich, E. R. Teaching mathematics as a system of understandings. *Mathematics Teacher*, 1949, 42: 61–66.

Brownell, W. A. The progressive nature of learning in mathematics. *Mathematics Teacher*, 1944, 37: 147–157.

Fawcett, Harold. Unifying concepts in mathematics. *Bulletin, Kansas Assoc. of Teachers of Mathematics*, 1947, 21: 59–62.

Johnson, J. T. Can concepts in elementary mathematics be developed? SCHOOL SCIENCE AND MATHEMATICS, 1944, 44: 146–154.

Kinney, L. B. and Freeman, F. N. Manner in which pupils learn mathematics. *California Journal of Secondary Education*, 1945, 20: 381–387.

The next group of references deals with meaning and understanding in arithmetic in particular.

Brownell, W. A. When is arithmetic meaningful? *Journal of Educational Research*, 1945, 38: 481–498.

Carter, Paul. From a mechanistic to a meaningful program of arithmetic instruction: a suggested approach. SCHOOL SCIENCE AND MATHEMATICS, 1947, 47: 604–608.

Dunfee, Maxine. Developing understanding in junior high school arithmetic. SCHOOL SCIENCE AND MATHEMATICS, 1948, 48: 734–740.

Ebert, Reuben. Generalization of abilities in mathematics. *Journal of Educational Research*, 1946, 39: 671–681.

Johnson, J. T. What do we mean by meaning in arithmetic? *Mathematics Teacher*, 1948, 41: 362–367.

Riess, Anita. The meaning of the "meaningful" teaching of arithmetic. *Elementary School Journal*, 1944, 45: 23–32.
Schaaf, W. L. Arithmetic taught as a basis for later mathematics. SCHOOL SCIENCE AND MATHEMATICS, 1946, 46: 413–423.
Van Engen, H. An analysis of meaning in arithmetic. *Elementary School Journal*, 1949, 49: 321–329; 395–400.
Wheat, H. G. Teaching thinking in arithmetic. *Mathematics Teacher*, 1947, 40: 217–220.
Wheat, H. G. Why not be sensible about meaning? *Mathematics Teacher*, 1945, 38: 99–102.

Since algebra may be regarded as generalized arithmetic, the implications of "teaching for meaning" are equally, if not more significant in this field. The insistence upon variation and functionality as a central idea, which began a quarter of a century ago, is good but by no means sufficient. The learner must come to understand the nature of algebraic thinking—involving, in addition to the concepts of variation, function, and equation, such concepts as general number, general operation, and above all, postulates concerning numbers and operations. The following references are pertinent.

Charosh, Mannis. Unifying elementary mathematics by means of fundamental concepts. *National Mathematics Magazine*, 1944, 19: 78–90.
Jerbert, A. R. Algebra and arithmetic. SCHOOL SCIENCE AND MATHEMATICS, 1945, 45: 528–540.
Kinsella, John. A "meaning" theory for algebra? SCHOOL SCIENCE AND MATHEMATICS, 1947, 47: 775–780.
Kinsella, John, and Carnahan, W. H. Putting meaning into algebraic concepts and relationships. SCHOOL SCIENCE AND MATHEMATICS, 1949, 49: 19–26.
Lazar, Nathan. A technique for giving meaning to elementary mathematical operations. *Mathematics Teacher*, 1949, 42: 67–68.
Picken, D. P. The arithmetic and algebra of the natural numbers. *Australian Mathematics Teacher*, 1946, 2: 25–30.
Tulley, Jean. Teaching algebra as generalized arithmetic. *Bulletin, California Mathematics Council*, 1949, 7: 10–12.
Van Engen, H. Logical approaches to $(-a)(-b)=ab$ and $x^0=1$. *Mathematics Teacher*, 1947, 40: 182–185.

As any teacher of arithmetic and algebra will readily admit, the teaching of "verbal problems" is at once one of the most difficult and most discouraging of undertakings. Despite a wealth of research over a score of years, including the study of various factors such as maturity, readiness, experience, language, reading skill, vocabulary, techniques, devices, step-analysis, algorisms and the like, effective learning of problem solving has consistently been a dismal disappointment. One of the major reasons for this lack of success is to be found in the fact that both teacher and learner have paid insufficient attention to the development of relational thinking. The next group of references deals with this consideration.

Brownell, W. A. Problem solving. *National Society for the Study of Education*, 1942, 41st Yearbook, Part II, pg. 415–443.

Johnson, J. T. (et al.) What is problem solving in arithmetic? SCHOOL SCIENCE AND MATHEMATICS, 1946, 46: 256–266.
Kinney, J. M. The function concept in the solution of problems of elementary algebra. SCHOOL SCIENCE AND MATHEMATICS, 1945, 45: 693–703.
Peak, Philip. Algebra problems and problems in life. *Mathematics Teacher*, 1948, 41: 266–269.
Rich, Barnett. Variation applied to problem-solving. *Mathematics Teacher*, 1947, 40: 158–165.
Schaaf, W. L. A realistic approach to problem-solving in arithmetic. *Elementary School Journal*, 1946, 46: 494–497.
Spangler, M. Why is the ability to recognize relationships in reading of problems so vital, and what methods can be used to develop this ability? SCHOOL SCIENCE AND MATHEMATICS, 1946, 46: 448–452.

In the teaching and learning of geometry, relational thinking, abstractions, and logic are of paramount importance. Geometry has been taught for many years as an example of critical thinking with the deliberate purpose of cultivating logical and relational thinking in other areas as well. At times, however, success was rather remote, although some progress can be reported, particularly since the important pioneer work of Fawcett, Christofferson, Nyberg, Lazar and others. Some of the recent articles which relate to this problem are given below.

Cantonwine, Paul. How to develop critical thinking about inter-group relations in the geometry classroom. *Mathematics Teacher*, 1949, 42: 247–251.
Charosh, Mannis. Possible transfer values of 10th year mathematics. *High Points*, 1941, 23: 71–76.
Christofferson, H. C. Geometry, a way of thinking. *Bulletin, Kansas Assoc. of Teachers of Mathematics*, 1944, 18: 105–111.
Cook, Inez. Developing reflective thinking through geometry. *Mathematics Teacher*, 1943, 36: 79–82.
Fawcett, H. Statement of a hypothesis concerning proof. *California Journal of Secondary Education*, 1941, 16: 180–185.
Goodstein, R. L. Proof by reductio ad absurdum. *Mathematical Gazette*, 1948, 32: 198–204.
Lazar, N. The logic of indirect proof in geometry. *Mathematics Teacher*, 1947, 40: 225–240.
Nyberg, J. A. Geometry, logic and social studies. *Social Studies*, v. 34, pp. 104–108.
Read, Lyle. A unit on assumptions in plane geometry. *Bulletin, Kansas Assoc. of Teachers of Mathematics*, 1942, 16: 37–39.
Salit, C. R. Geometry as a natural way of thinking. *Education*, 1946, 67: 28–33.
Ullsvik, Bjarne. An attempt to measure critical judgement. SCHOOL SCIENCE AND MATHEMATICS, 1949, 49: 445–452.
Ulmer, Gilbert. Some suggestions for teaching geometry to develop clear thinking. University of Kansas, *Studies in Education*, 1942, v. 2, No. 7.

2. GUIDANCE IN MATHEMATICS

Effective guidance of high school pupils has greatly improved in the last few years. It was, of course, long overdue. Considerable progress has already been made. The best single source of data for

the teacher or counselor is the *Guidance Pamphlet in Mathematics for High School Students,* a 25-page report of the Commission on Post War Plans of the National Council of Teachers of Mathematics, first published in November, 1947. The fact that nearly 30,000 copies of this report have already been distributed is highly significant. Guidance charts, similar to that which appears opposite page 75 of the February, 1949 issue of the *Mathematics Teacher,* are rapidly becoming commonplace in schools throughout the nation; some of these are prepared by professional agencies, others are "homemade" charts prepared by teachers or pupils. However, the surface has hardly been scratched. At least two major gaps still remain to be filled. First, more descriptive material concerning the needs of mathematics in various trades, vocations, semi-professions and professions must be prepared. Such material should be explicit and specific, and should be extended to cover a much broader variety of occupations than those already publicized. Indeed, detailed, descriptive and expository discussions of this kind should also include the personal and "consumer" values of mathematical understandings in addition to the vocational values. And above all, this literature must find an even wider circulation and dissemination—among parents as well as pupils, among school administrators, guidance counselors, teachers of other subjects, and businessmen as well as mathematics teachers. In the second place, mathematics teachers and guidance counselors must familiarize themselves more thoroughly with the *specific nature of the activities* in many vocational areas, and particularly with the nature of the mathematics involved in those areas. Vague or general allusions to "mathematical needs" are not nearly as dramatic or effective as specific, concrete illustrations of problems or processes actually encountered on the job. Here is another excellent reason for including "work experience" in the shop, the drafting room, the laboratory, the office, or the bank as a required part of the training of secondary mathematics teachers.

Since this is a matter of such great importance in the changing climate of secondary education, and in view of the needs just alluded to, it is believed that the following references to recent literature will be valuable; the list is far from complete, but includes some of the more useful source material.

Bartky, A. J. Guidance in mathematics. *Bulletin, Kansas Assoc. of Teachers of Math.,* 1947, 21: 45–47.

Burr, Harriet. Guidance for girls in mathematics. *Mathematics Teacher,* 1943, 36: 203–211.

Cooper, J. G. Mathematical requirements of jobs open to high school students. *Bulletin, California Mathematics Council,* 1948, 6: 13–15.

Edwards, P. D. Minimum mathematical preparation for various college curricula. SCHOOL SCIENCE AND MATHEMATICS, 1949, 49: 181–187.

Gerhard, F. B. The actuarial profession. *American Mathematical Monthly*, 1948, 55: 481–487.
The Mathematician in Civil Service. *The Pentagon*, 1948, 8: 25–30.
National Research Council, Committee on Applied Mathematical Statistics. Personnel and training problems created by the recent growth of applied statistics in the U. S. Washington, D. C., the *Council*, 1947, 26 pp.
Nielsen, K. L. The mathematical engineer or the industrial mathematician. *Journal of Engineering Education*, 1947, 38: 175–180.
Nielsen, K. L. The use of mathematics in government research. *Mathematics Magazine*, 1948, 21: 193–194.
Price, G. B. Careers in mathematics. *Bulletin, Kansas Assoc. of Teachers of Mathematics*, 1947, 22: 3–10.
Richtmeyer, C. C. How can we help high-school counselors understand the values of mathematics? *The Pentagon*, 1945, 5: 11–18.
Schorling, Raleigh. Let's come to grips with the guidance problem in mathematics. *Mathematics Teacher*, 1949, 42: 25–28.
Siemens, C. H. Functional guidance in mathematics. *Bulletin, California Mathematics Council*, 1948, 6: 7–8.
Sokolnikoff, I. S. Opportunities for mathematically trained college graduates. *Mathematics Magazine*, 1947, 21: 102–105.
Sullivan, Sister Helen. Opportunities for women trained in mathematics. *The Pentagon*, 1944–45, 4: 5–14.
Sundberg, E. C. Guidance techniques in the mathematics program at the Francis Polytechnic High School in Los Angeles. *Bulletin, California Mathematics Council*, 1947, 5: 7–8.
United States Department of Labor, Women's Bureau. *The Outlook for Women in Mathematics and Statistics*. Washington, D. C., Government Printing Office, 1948; 21 pp.
Walls, Nancy. Careers for graduates in mathematics. *Mathematical Gazette*, 1947, 31: 93–97.
Zant, James H. Mathematics—its vocational aspects. *Bulletin, Oklahoma A. and M. College*, 1945, 42: 1–30.
Zant, James H. What are the mathematical needs of the high school student? *Mathematics Teacher*, 1949, 42: 75–78.

3. Audio-Visual Aids

Although some use has always been made of models, charts, slides and so on, the effect of the late war upon the use of such visual material was to provide a very decided impetus, especially in connection with films and filmstrips. Perhaps the full impact has not yet been felt, and it may be too early to appraise the present trend to employ in increasing degree projected visual material. In any event, the net value of its use is closely related to our objectives; and the chief criterion must of course be, does the use of the film or filmstrip serve to do any better what the teacher could do without them? Projected material which is similar to that in the textbook; material which merely tells instead of stimulates; material which stresses facts rather than thought processes; material which fails to utilize the unique contribution of the film (motion, sequence, animation, etc.) or the unique contribution of the slide (color, composition, dramatic values, etc.)—all such material is of dubious value. It is entirely pos-

sible that we may, in our enthusiasm, come to expect too much from the use of visual aids.

However, it is only fair to point out that students of the subject are currently devoting considerable attention to this field, and that producers of films and other aids are meeting the challenge constructively. Definitive appraisal must be deferred for the time being. Meanwhile the literature is growing by leaps and bounds. The best single source on visual aids of all kinds, as applied to mathematics, is the 18th Yearbook of the National Council of Teachers of Mathematics (1945). To keep up with the new films, filmstrips, models, charts, booklets, etc., that appear in rapid succession is not easy; the task has been notably simplified by the very helpful monthly reports of Henry W. Syer and Donovan A. Johnson which have been appearing regularly in the issues of the *Mathematics Teacher* since March, 1948, under the title "*Aids to Teaching.*"

The following pamphlets and monographs will bring the reader up to date; nothing like a *complete* list of materials available, or of the literature, has as yet appeared.

Mathematics: Visual and Teaching Aids. New Jersey State Teachers College, Upper Montclair, N. J., 1947. Mimeographed; 30 pp.; 75¢.

Bibliography of Mathematical Motion Picture Films, Film Strips, Slides and Stereographs. P. A. Chapdelaine, Iowa State Teachers College, Cedar Falls, Ia., 1948. Printed; 41 pp.; 75¢.

Exploring the Teaching of Mathematics: Multi-sensory Aids to Learning Mathematics. Cooperative Report of Third Summer Workshop, College of Education, Ohio State University, 1947. Mimeographed; 53 pp.

A Bibliography of Mathematics Films and Filmstrips, compiled by D. A. Johnson and H. W. Syer, Spring, 1949. Mimeographed; 13 pp.; available from Henry W. Syer, Boston University, Boston, Mass.

A Bibliography of Non-projected Multi-sensory Aids for the Teaching of Secondary Mathematics, compiled by Bernard M. Singer, 1948. Mimeographed; 32 pp.; available from H. W. Syer, Boston University.

As for recent articles in the literature, the following are among the more important:

Fehr, Howard. The place of multi-sensory aids in the teacher training program. *Mathematics Teacher*, 1947, 40: 212–216.

Johnson, D. and Nickerson, J. The future of visual aids in mathematics. *Mathematics Teacher*, 1947, 40: 180–181.

Jones, Phillip S. Multi-sensory aids based on applications of mathematics. *Mathematics Teacher*, 1947, 40: 285–293.

The Place of Visual Aids in the Teaching of Mathematics. *Mathematical Gazette*, 1947, 31: 193–205.

Reeve, W. D. Multi-sensory aids in teaching mathematics. *Teachers College Record*, 1945, 46: 420–427.

Rosskopf, M. F. and Montgomery, G. C. A department of mathematics prepares an exhibit. *Mathematics Teacher*, 1949, 42: 187–191.

Schacht, J. F. and Kinsella, J. J. Dynamic geometry. *Mathematics Teacher*, 1947, 40: 151–157.

Sturtevant, E. B. Visual aids in the mathematics classroom. *Bulletin, California Mathematics Council*, 1947, 5: 16–18.

Syer, Henry W. The use of facsimiles for the teaching of elementary mathematics. SCHOOL SCIENCE AND MATHEMATICS, 1943, 43: 69–78.
Syer, H. W. and Ingeneri, P. J. Multi-sensory aids in mathematics. SCHOOL SCIENCE AND MATHEMATICS, 1949, 49: 134–140.

4. ENRICHMENT MATERIALS

Admittedly the terms "enriched teaching" and "enrichment materials" are used somewhat loosely, but that need not detract too much from their usefulness and convenience. With reference to mathematics teaching, enrichment or background materials would perhaps include: (1) the *uses of mathematics* in business, economics, industry, science, technology, engineering, mechanical trades, specialized fields such as radio, aviation, navigation, surveying, cartography, and the like, as well as a variety of miscellaneous practical applications; (2) the *appreciation of mathematics*, as, for example, its historical development, its logical foundations and philosophy, the relation of mathematics to Nature, mathematics and the fine arts, and various other "sidelights" and "excursions" in mathematics—humanism, poetry, humor, curiosities, and the like; (3) *recreational mathematics*, including puzzles, tricks, games, amusements, paradoxes, mathematical projects, field work, plays and pageants, club and assembly programs, mathematical exhibits, and the making of mathematical models, charts, simple instruments; (4) *mathematical instruments and laboratory mathematics*, including geometric constructions, models, string figures, geometric dissections, linkages, the mechanical construction of curves, nomography, early devices for mechanical computation, slide rules, modern calculating and accounting machines, ancient and modern surveying instruments, measuring instruments, mechanical solution of equations, planimeters, integrators, differential analyzers and recent developments in mathematical machines.

It might frankly be pointed out that new entrants into the teaching profession, while generally well prepared both in pure mathematics and in educational theory, are regrettably weak in these "background" aspects of mathematics. This is understandable, but scarcely excusable; if conventional courses in mathematics and in education do not deal adequately with such material, then provisions for its inclusion are in order. Drawing upon backgrounds of mathematical utility, appreciation, enjoyment, and equipment in teaching is extremely significant; it can make a maximal contribution only if the teacher has an adequate mastery of a sufficiently wide variety of material. The literature in each of these background areas is indeed rich; even a selective bibliography would require far more space than is available here, so that only a very few high spots can be mentioned.

As for the uses of mathematics, there are the usual textbooks on business and financial mathematics, on vocational and shop mathe-

matics, on engineering mathematics, and on the mathematics of radio, navigation, aviation and the like; for a partial list of such texts the reader may refer to the writer's paper on the literature of military mathematics, in *Scripta Mathematica*, 1945, 11: 57–74; 121–137, which, however, should be brought up to date. Other helpful source material on the applications of mathematics will be found in the following:

Mathematics in Modern Life, 6th Yearbook, National Council of Teachers of Mathematics, 1931; 195 pp.

A Sourcebook of Mathematical Applications, 17th Yearbook, National Council of Teachers of Mathematics, 1942; 291 pp.

Mathematics at Work, A Report of the Mathematics Institute, Duke University, Durham, N. C., 1948; 94 pp.

The National Applied Mathematics Laboratories—A Prospectus, by John R. Steelman, Washington, D. C., Government Printing Office, 1947.

Unfortunately, the last item listed has been out of print for some time, but reprints of a paper by J. H. Curtiss entitled "A Federal Program in Applied Mathematics," which appeared in *Science*, 1948, 107: 257–262, may be obtained from the national Bureau of Standards, Washington, D.C.

Many excellent books have appeared in the last ten or fifteen years which deal with expository mathematics. In addition to the well known works by E. T. Bell, T. Dantzig, C. J. Keyser, L. Hogben, L. R. and H. G. Lieber, the following few titles, culled from among many others, may serve as a point of departure for the teacher intent upon greater appreciation of mathematics.

Anderson, R. W. *Romping Through Mathematics*. A. Knopf, 1947.

Gamow, George. *One, Two, Three . . . Infinity*. Viking Press, 1948.

Hardy, G. *A Mathematician's Apology*. Cambridge University Press, 1940.

Hopper, A. *The River Mathematics*. H. Holt, 1945.

Kasner, E. and Newman, J. *Mathematics and the Imagination*. Simon & Schuster, 1940.

Kattsoff, L. O. *A Philosophy of Mathematics*. Iowa State College Press, 1948.

Kokomoor, F. W. *Mathematics in Human Affairs*. Prentice-Hall, 1942.

Polya, G. *How to Solve It*. Princeton University Press, 1945.

Schaaf, W. L. (Ed.) *Mathematics: Our Great Heritage*. Harper & Bros., 1948.

Steinhaus, H. *Mathematical Snapshots*. New York, G. E. Stechert & Co., n. d.

Van Horn, C. E. *A Preface to Mathematics*. Boston, Chapman & Grimes, 1938.

Wertheimer, Max. *Productive Thinking*. Harper and Bros., 1943.

Weyl, Herman. *Philosophy of Mathematics and Natural Science*. Princeton University Press, 1949.

On the history of mathematics, we can only add a few volumes which will supplement the standard works by W. W. R. Ball, F. Cajori, T. L. Heath, Vera Sanford, D. E. Smith, J. W. N. Sullivan and others, These would include:

Archibald, R. C. *Outline of the History of Mathematics*. 6th Edit., Mathematical Assoc. of America, 1947, 1949.

Bell, E. T. *The Development of Mathematics.* McGraw Hill, 1940.
Bell, E. T. *Men of Mathematics.* Simon & Schuster, 1937.
Boyer, Carl. *The Concepts of the Calculus.* Columbia University Press, 1939.
Hooper, A. *Makers of Mathematics.* Random House, 1947.
Struik, D. J. *Concise History of Mathematics.* Dover Publishing Co., 1948.

On the relation of mathematics to the fine arts, much has been written also. The work of George Birkhoff, Rutherford Boyd, Claude Bragdon and Jay Hambridge is well known. A few recent or possibly less well known titles follow:

Baravalle, H. *Geometric Drawing.* 18th Yearbook, National Council of Teachers of Mathematics, 1945, pp. 64–81.
Bradley, A. D. *Geometry of Repeating Design.* Teachers College, Columbia University, 1933.
Crane, Walter. *The Bases of Design.* London, G. Bell & Sons, 1925.
Edwards, E. B. *Dynamarkythmic Design.* Appleton-Century, 1938.
Ghyka, Matilda. *The Geometry of Art and Life.* N. Y., Sheed & Ward, 1946.
Hornung, C. P. *Handbook of Designs and Devices.* Revised edition. N. Y., Dover Publications, 1946.
Ivins, William. *Art and Geometry.* Harvard University Press, 1946.
Lietzmann, W. *Mathematik und Bildende Kunst.* Breslau, F. Hirt, 1931.
Richter, Irma. *Rhythmic Form in Art.* London, John Lane, 1932.
Schillinger, Joseph. *The Mathematical Basis of the Arts.* N. Y., Philosophical Library, 1948.
Somervell, Edith. *A Rhythmic Approach to Mathematics.* London, 1906. (Available from Miss L. E. Christman, 1217 Elmdale Ave., Chicago, Ill.)
Spanton, J. H. *Geometrical Drawing and Design.* Macmillan, 1930.
Sykes, Mabel. *Source Book of Problems for Geometry.* Allyn & Bacon, 1912.
Wolff, Georg. *Mathematik und Malerei.* Leipzig, Teubner, 1925.
Wolff, Georg. *Mathematics and the Arts.* 11th Yearbook, National Council of Teachers of Mathematics, 1936, pp. 226–244.

Lack of space precludes the listing of material on mathematical recreations, which is abundant and readily accessible. Source materials on mathematics in nature are less abundant; Darcy Thompson's well known *Essays on Growth and Form* has recently been revised, and Bentley and Humphrey's remarkable volume *Snow Crystals* (McGraw-Hill, 1931) deserves wider recognition.

As for material on mathematical instruments, calculating machines, laboratory methods and equipment, models, etc., there is tremendous amount of material, but it is widely scattered. The same may be said of the literature on the theory of measurement, weights and measures, and measuring instruments. We record simply a few recent items of value.

Surveying Instruments. E. R. Kiely; 19th Yearbook, National Council of Teachers of Mathematics, 1947.
The Metric System of Weights and Measures. J. T. Johnson; 20th Yearbook, National Council of Teachers of Mathematics, 1948.
How Much and How Many: The Story of Weights and Measures. Jeanne Bendick, Whittlesey House, McGraw-Hill, 1947.
Geometrical Tools: A Mathematical Sketch and Model Book. Robert C. Yates, Educational Publishers, Inc., St. Louis, Mo., 1949.

The Theory of Mathematical Machines. F. J. Murray, King's Crown Press, 1947–1948.

Good bibliographic material in these latter areas has yet to be compiled.

In conclusion, two other trends in mathematical education remain to be noted: (1) the efforts in many places to organize mathematics effectively and functionally for general education, and (2) attempts to devise and use more critical methods of evaluating the outcomes of instruction and achievement of the learner. Both trends are increasing in importance, and the literature is beginning to accumulate; lack of space once more makes it impossible to give specific references.

GENERAL SCIENCE AT OKLAHOMA

The University of Oklahoma has set up an interdepartmental general science course for teachers, to be given for the first time this fall.

The courses are set up in two semesters, the first semester to be physical science, and the second semester biological science. The Department of Physics is providing classrooms, laboratory facilities, and the instructor for the first semester's work, while the Department of Plant Sciences and the Department of Zoology will collaborate on provision of classroom space and instructors for the second semester. All major science departments on the campus are making financial contributions to the establishment and the first year's operation of the courses, as well as providing special lecturers as necessary.

The special objectives of the teachers' science courses are (1) to provide a more nearly adequate general science background for prospective elementary teachers; (2) to provide broad science contact for prospective teachers of secondary school science, as well as experience in a general science course before having to teach such courses, and (3) to provide broader acquaintance with science fields for teachers of non-science courses. The courses will seek to achieve their objectives through (a) developing an understanding of scientific method (induction, deduction, verification); (b) developing a knowledge of the history of science, regarded as a construction by human personalities and a way of meeting the problems of men; (c) through the use of selected problems that will illustrate the effects of science in the modern social order and that will arouse and maintain student interest, and (d) through integrated lecture-laboratory teaching which emphasizes source materials from the students' immediate surroundings.

A BOOKLET FOR THE THIRD GRADE

A new booklet for third grade pupils has been prepared by United Air Lines as an aviation aid to teachers. The booklet, "Mike And Nancy Take A Flight," is a supplement to an earlier story on "Mike And Nancy At The Airport." The new story takes nine-year-old Mike and eight-year-old Nancy on a holiday flight from Chicago to California.

The four-page illustrated booklet is available without charge in sets of 40 upon request from the nearest United school and college service office. Such offices are located in Chicago, New York, Los Angeles, San Francisco and Seattle.

A BIBLIOGRAPHY OF MATHEMATICS FILMS AND FILMSTRIPS

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Boston University, Boston, Mass.

This is a bibliography of sound motion picture films and filmstrips available for the teaching of arithmetic and mathematics. Titles are listed without regard for the quality or appropriateness of the film or filmstrip. Many of the titles of this article are reviewed in the monthly section "Aids to Teaching" of *The Mathematics Teacher*. All films listed are one reel 16 mm., black and white, sound motion pictures and all filmstrips are black and white, 35 mm. filmstrips unless a notation to the contrary is given. Only one source is given, usually the producer, for each title. The complete name and address of each company is given at the end of the bibliography. The teacher wishing to rent a film or purchase a filmstrip should check the availability of the title in the catalogs of local audio-visual libraries and/or commercial film outlets. To facilitate the use of this listing, all titles are grouped according to grade level. It is the hope of the writers that this bibliography will be used by teachers of arithmetic and mathematics to obtain visual aids for more effective teaching.

Primary Grades 1–3

Films

About Money	Children's Productions
Addition is Easy	Coronet Films
Let's Count	Coronet Films
Parts of Nine	Young America
Parts of Things	Young America
Subtraction Is Easy	Coronet Films
The Teen Numbers	Young America
What is Four	Young America

Filmstrips

Compound Subtraction	Popular Science Publishing Co.
Counting to 5	Encyclopaedia Britannica
Counting to 10	Encyclopaedia Britannica
Counting from 10–15	Encyclopaedia Britannica
Counting from 15–20	Encyclopaedia Britannica
Counting from 20–40	Encyclopaedia Britannica
Counting from 40–100	Encyclopaedia Britannica
Counting by 10's to 30	Encyclopaedia Britannica
Counting by 10's to 50	Encyclopaedia Britannica
Counting by 10's to 80	Encyclopaedia Britannica
Counting by 10's to 100	Encyclopaedia Britannica
How To Tell Time, Parts I and II	Popular Science Publishing Co.

A Number Family in Addition (Color $5)	Popular Science Publishing Co.
Telling Time	Young America
The Threes (Color $5)	Popular Science Publishing Co.
The Twos in Division (Color $5)	Popular Science Publishing Co.
Using Numbers	Encyclopedia Britannica
What Numbers Mean (Color $5)	Popular Science Publishing Co.
Working with Numbers to 100	Encyclopaedia Britannica
Writing Numbers to 10	Encyclopaedia Britannica
Writing Numbers to 100	Encyclopaedia Britannica
Zero—A Place Holder (Color $5)	Popular Science Publishing Co.

Intermediate Grades 4–6

Films

Borrowing in Subtraction	Teaching Films Custodians
Decimal Fractions (Black and white or color)	Johnson Hunt Productions
Division of Fractions	Knowledge Builders
How to Add Fractions (Black and white or color)	Johnson Hunt Productions
How to Change Fractions (Black and white or color)	Johnson Hunt Productions
How to Divide Fractions (Black and white or color)	Johnson Hunt Productions
How to Multiply Fractions (Black and white or color)	Johnson Hunt Productions
How to Subtract Fractions (Black and white or color)	Johnson Hunt Productions
Introduction to Fractions (Black and white or color)	Johnson Hunt Productions
Meaning of Long Division	Encyclopaedia Britannica
Meaning of Percentage	Young America
Multiplying Fractions	Knowledge Builders
Per cent in Everyday Life (Black and white or color)	Coronet Films
Percentage (Black and white or color)	Johnson Hunt Productions
Simple Fractions	Knowledge Builders
We Discover Fractions (Black and white or color)	Coronet Films
What Are Fractions	Films, Inc.

Junior High School Mathematics

Films

Anne Learns About Ocean Liners	Arizona University
Banks and Credit	Coronet Films
Caught Mapping	General Motors
Check and Double Check	Aetna Life Insurance Co.
Consumer Protection	Coronet Films
Credit Unions—John Doe's Bank	Cooperative League Film Dept.
Credit Unions—The People's Bank	Cooperative League Film Dept.
Doubtful Dollars (Color)	Aetna Life Insurance Co.
Earth—Latitude and Longitude	American Film Registry
Face of the Earth	American Film Registry
Federal Taxation	Coronet Films
Fred Meets a Bank	Coronet Films
Global Concepts in Maps (Black and white or color)	Coronet Films
Impossible Map, The (Color)	National Film Board of Canada
Installment Buying	Coronet Films
Know Your Money	U.S. Secret Service
Maps are Fun	Coronet Films

Measurement (Black and white or color)	Coronet Films
Money at Work	Modern Talking Picture Service
Money to Loan	Indiana University
People's Bank, The	National Film Board of Canada
Precisely So	General Motors Corp.
Principles of Scale Drawing	Coronet Films
Property Taxation	Encyclopaedia Britannica
Search for Security—Story of Life Insurance	United World Films
Sharing Economic Risks	University of Illinois
Sign of Dependable Credit	Kansas University
Social Security	Social Security Board
Social Security for the Nation	Social Security Board
Story of Money	International Films
Time—The Servant of Man	Modern Talking Picture Service
Using the Bank (Black and white or color)	Encyclopaedia Britannica
What Is Business	Coronet Films
What Is a Contract	Coronet Films
What Is Money (Black and white or color)	Coronet Films
Work of the Stock Exchange (Black and white or color)	Coronet Films
Your Thrift Habits	Coronet Films

Filmstrips

Addition and Subtraction (16 frames $4)	Jam Handy
Area of Rectangles—Area of Parallelograms	Photo and Sound Productions
Area of Triangles—Area of Trapezoids	Photo and Sound Productions
Banking as a Career ($2)	Society for Visual Education
Better Buymanship (81 frames, $2)	Household Finance Corp.
Changing Fractions to a Common Denominator Part A (25 frames)	Photo and Sound Productions
Changing Fractions to a Common Denominator Part B (25 frames)	Photo and Sound Productions
The Circle	Photo and Sound Productions
Comparing Fractions—Adding and Subtracting (25 frames)	Photo and Sound Productions
Compound Subtraction (Color $5)	Popular Science Publishing Co.
Credit (105 frames, $2)	Household Finance Corp.
Cubic Measure—Volume	Photo and Sound Productions
Dividing Fractions (25 frames)	Photo and Sound Productions
Fractions, Decimals and Percentage (55 frames $4)	Jam Handy
George Clark's Cartoons on Money Management (17 frames, $1)	Household Finance Corp.
History of Area Measurement	Young America
History of Linear Measure	Young America
Improper Fractions—Mixed Numbers (25 frames)	Photo and Sound Productions
International Date Line	Popular Science Publishing Co.
Linear Measure	Photo and Sound Productions
Lines and Angles	Photo and Sound Productions
Maps and Men	Popular Science Publishing Co.
Maps and Their Meaning	Popular Science Publishing Co.
Money Management (17 frames, $2)	Household Finance Corp.
Mrs. Consumer Considers Credit	Household Finance Corp.
Multiple Fractions—Improper Fractions (25 frames)	Photo and Sound Productions
Multiple Fractions—Numerator and Denominator (25 frames)	Photo and Sound Productions

Multiplication and Division (27 frames, $4)	Jam Handy
Multiplication and Division of Fractions (21 frames $4)	Jam Handy
Multiplying Fractions (25 frames)	Photo and Sound Productions
Number System	Young America
Reciprocals—The Rule of Division (25 frames)	Photo and Sound Productions
Reducing and Changing Fractions (25 frames)	Photo and Sound Productions
Scales and Models (80 frames, $4)	Jam Handy
Special Measurement	Photo and Sound Productions
Story of Measurement	Photo and Sound Productions
Time	Popular Science Publishing Co.
Timekeepers Through the Ages (41 frames)	Visual Science
Units and Fractional Parts (25 frames)	Photo and Sound Productions
Weight and Volume	Young America
We Live on a Huge Ball	Popular Science Publishing Co.

Measuring Instruments

Films

Bevel Protractor, The	United World Films
Dial Indicator	Federal Products Corporation
Fixed Gages	United World Films
Gage Blocks and Accessories	United World Films
Height Gages and Test Indicators	United World Films
Measurement with Light Waves	United World Films
Micrometer	United World Films
Principal Dimensions, Reference Surfaces, and Tolerances	United World Films
Principle of Moments	United World Films
Reading a Three-View Drawing	United World Films
The Steel Rule	United World Films
Verniers	United World Films
Visualizing an Object	United World Films

Filmstrips

Blue Print Reading ($4)	United World Films
Calculation Instruments: Graphical Methods, Slide Rules, and Solving Equations ($2)	Society for Visual Education
Calculation Instruments: Business Machines Part I Early Methods ($2)	Society for Visual Education
Calculation Instruments: Business Machines Part II Advanced Methods ($2)	Society for Visual Education
Calendar	Young America
Fixed Gages ($1)	United World Films
Flat Map of a Round Earth	Popular Science Publishing Co.
Height Gages and Standard Indicators ($1)	United World Films
Layout Tools and Measuring Instruments (96 frames, $4.50)	Jam Handy
Layout Work ($4.50)	Jam Handy
Measurements and Measuring: Part I (50 frames, $4.50)	Jam Handy
Measurements and Measuring: Part II (64 frames, $4.50)	Jam Handy
Micrometer ($1)	United World Films
Vernier	United World Films

Algebra

Films

Algebra in Everyday Life	Coronet Films
Language of Graphs (Black and white or color)	Coronet Films

Origin of Mathematics	Ideal Pictures Corporation
Thousand Hours, A	Jam Handy

Filmstrips

Addition and Subtraction of Signed Numbers	Society for Visual Education
Algebra ($2)	Society for Visual Education
Arithmetic of Algebra (40 frames, $4)	Jam Handy
Equations and Formulas (53 frames, $4)	Jam Handy
Exponents and Logarithms (70 frames, $4)	Jam Handy
Five Keys to Mathematics (46 frames, $4)	Jam Handy
Formulas	Society for Visual Education
Graph Uses (49 frames, $4)	Jam Handy
Graphs	Society for Visual Education
Introduction to Algebra ($2)	Society for Visual Education
Introduction to Equations ($2)	Society for Visual Education
Introduction to Signed Numbers ($2)	Society for Visual Education
Multiplication and Division of Signed Numbers	Society for Visual Education
Order of Operation (37 frames, $4)	Jam Handy
Plotting Graphs (62 frames, $4)	Jam Handy
Positive and Negative Numbers (48 frames, $4)	Jam Handy
Problem Analysis (37 frames, $4)	Jam Handy
Square Root and Cube Root (46 frames, $4)	Jam Handy

Geometry

Films

Angles	Knowledge Builders
Angles and Arcs in Circles	Knowledge Builders
Areas	Knowledge Builders
Chords and Tangents of Circles	Knowledge Builders
Circle, The	Knowledge Builders
Congruent Figures	Knowledge Builders
Does It Matter What You Think	Ideal Pictures Corp.
Einstein's Theory of Relativity (Silent)	Ideal Films Corp.
Geometry and You	Coronet Films
Geometry in Action	Bald Eagle Film Productions
How to Judge Authorities	Coronet Films
Indirect Measurement	Knowledge Builders
Introduction to Vectors	United World Films
Lines and Angles	Knowledge Builders
Locus	Knowledge Builders
Polygons	Knowledge Builders
Properties of Triangles	Knowledge Builders
Pythagorean Theorem	Knowledge Builders
Quadrilaterals	Knowledge Builders
Ratio and Proportion	Knowledge Builders
Similar Triangles	Knowledge Builders

Filmstrips

Addition and Subtraction in Geometry (51 frames, $4)	Jam Handy
Angular Measurement (68 frames, $4)	Jam Handy
Areas	Society for Visual Education
Basic Angles in Experimental Geometry	Society for Visual Education
Basic Triangles	Society for Visual Education
Common Tangents and Tangent Circles	Society for Visual Education
Congruent and Overlapping Triangles	Society for Visual Education
Constructions (57 frames, $4)	Jam Handy
Deductive Reasoning (Color $5)	Curriculum Films

Definitions and Key Words (Color, $5)	Curriculum Films
Force and Velocity as Vectors (50 frames, $4.50)	Jam Handy
Geometric Construction Part I, 72¢; Part II, 72¢	United World Films
Geometry in Art (Color $5)	Curriculum Films
Induction, Analysis, and Indirect Reasoning (Color, $5)	Curriculum Films
Introduction to Circles ($2)	Society for Visual Education
Introduction to Demonstrative Geometry ($2)	Society for Visual Education
Introduction to Plane Geometry ($2)	Society for Visual Education
Introduction to Plane Geometry (Color $5)	Curriculum Films
Introduction to Vectors, Co-planar and Concurrent Forces ($1)	United World Films
Lines	Jam Handy
Locus (Color $5)	Curriculum Films
Loci ($2)	Society for Visual Education
Measurement Instruments: In the Laboratory ($2)	Society for Visual Education
Measurement Instruments: Outside the Laboratory ($2)	Society for Visual Education
Mathematics and the Pilot ($4)	Jam Handy
Mistakes in Thinking (Color $5)	Curriculum Films
More Shapes	Jam Handy
Multiplication and Division in Geometry (48 frames, $4)	Jam Handy
Optical Illusions ($2)	Visual Science
Parallel Lines and Transversals ($2)	Society for Visual Education
Postulates: Triangles and Circles (Color, $5)	Curriculum Films
Postulates: Lines (Color, $5)	Curriculum Films
Quadrilaterals ($2)	Society for Visual Education
Ratio and Proportion (40 frames, $4)	Jam Handy
Shapes	Jam Handy
Similar Polygons ($2)	Society for Visual Education
Solid Shapes	Jam Handy
Vectors (2 frames, $4)	Jam Handy
Vocabulary: Circle, Part I (Color $5)	Curriculum Films
Vocabulary: Circles, Part II (Color $5)	Curriculum Films
Vocabulary: Polygons (Color $5)	Curriculum Films
Vocabulary: Triangles (Color $5)	Curriculum Films
Vocabulary: Lines and Angles, I (Color $5)	Curriculum Films
Vocabulary: Lines and Angles, II Relationships (Color $5)	Curriculum Films
Vocabulary: Lines, Relationships-Direction, Perpendicular Lines (Color $5)	Curriculum Films

Advanced Mathematics

Films

Frequency Curves (Silent)	Encyclopaedia Britannica
Isograph	Bell Telephone Laboratories
Parabola	Rutherford R. Boyd
Periodic Functions	United World Films
Rectangular Coordinates	Knowledge Builders
The Slide Rule: C and D Scales	United World Films
The Slide Rule: Proportion, Percentage, Squares and Square Root	United World Films

Filmstrips

Analytic Geometry (36 frames, $4)	Jam Handy
Areas by Integration ($2)	Society for Visual Education
Areas by Integration Using Polar Coordinates	Society for Visual Education
Double Integrals ($2)	Society for Visual Education
Slide Rule I: C and D Scales ($1)	United World Films
Slide Rule II: Proportion, Percentage, Squares and Square Root ($1)	United World Films
Trigonometry (35 frames, $4)	Jam Handy
Triple Integral ($2)	Society for Visual Education

Navigation

Films

Celestial Navigation: Bearings, Single Line of Position and Fixes	United World Films
Celestial Navigation: Charts	United World Films
Celestial Navigation: The Earth	United World Films
Celestial Navigation: Introduction and Location of Celestial Points	United World Films
Celestial Navigation: Nautical Astronomy	United World Films
Celestial Navigation: Solution of Illustrative Problems in Celestial Navigation	United World Films
Celestial Navigation: Time	United World Films
Navigation: Star Identification	United World Films
Navigation: Time	United World Films

Filmstrips

Aerial Navigation: Dead Reckoning. Part I: Radius of Action—Return to Same Base	United World Films
Aerial Navigation: Dead Reckoning. Part II: Radius of Action—Return to Alternate or Moving Base	United World Films
Dead Reckoning	Jam Handy

Names and Addresses of Film Companies

Aetna Life Insurance Company; Hartford 15, Conn.
American Film Registry; 28 East Jackson Street; Chicago, Illinois
Arizona University, Extension Division; Tucson, Arizona
Bald Eagle Film Productions; New Haven, Conn.
Bell Telephone Laboratories; 463 West Street, New York, New York
Children's Productions; Box 1313, Palo Alto, California
Cooperative League Film Department; 167 West 12th Street, New York 11, N. Y.
Coronet Films, Inc.; Coronet Building, Chicago 1, Illinois
Curriculum Films; R.K.O. Building, Radio City, New York, N. Y.
Encyclopaedia Britannica Films, Inc.; 20 North Wacker Drive, Chicago 6, Ill.
Federal Products Corporation; 1144 Eddy St., Providence, Rhode Island
Films, Inc.; 330 West 42nd Street, New York, New York
General Motors Corporation; Dept. of Public Relations, 1775 Broadway, New York, N. Y.
Household Finance Corporation; 919 North Michigan Avenue, Chicago 11, Ill.
Ideal Pictures Corp., 28 East 8th Street, Chicago, Ill.
Illinois University, Extension Division; Urbana, Ill.
International Films Bureau; Suite 1500, 6 No. Michigan Ave., Chicago, Ill.
Indiana University; Bureau of Audio Visual Aids, Bloomington, Indiana
Jam Handy Company; 2900 East Grand Boulevard, Detroit 11, Mich.
Johnson Hunt Productions; 1133 North Highland Ave., Hollywood 38, Calif.
Kansas University; Bureau of Visual Education, Lawrence, Kan.

Knowledge Builders Classroom Films; 625 Madison Ave., New York 22, N. Y.
Modern Talking Picture Service; 9 Rockefeller Plaza, New York 20, N. Y.
National Film Board of Canada; 620 Fifth Avenue, New York 20, N. Y.
Photo and Sound Productions; 116 Natoma Street, San Francisco 5, Calif.
Popular Science Publishing Company; Audio Visual Inc., 353 Fourth Ave., New York, N. Y.
Rutherford R. Boyd; Leonia, N. J.
Society for Visual Education; 100 East Ohio Street, Chicago, Ill.
Social Security Board, Washington, D. C.
Teaching Films Custodians; 25 West 43rd Street, New York 18, N. Y.
United States Secret Service, Washington, D. C.
United World Films; 445 Park Ave., New York 22, N. Y.
Visual Science; Suffern, N. Y.
Young America Films, Inc.; 18 East 41st St., New York 17, N. Y.

BROCHURE AVAILABLE SHOWING FM RADIO CENTER

A new brochure, describing the establishment of FM radio centers in high schools and colleges, is now available from the General Electric Company at Electronics Park, Syracuse, N. Y.

In addition to specifications for radio center layouts, the brochure suggests types of programs which may be presented.

Three basic station layouts are illustrated. Plan 1 shows the 10-watt station and lists all technical equipment needed. Plan 2 illustrates a more elaborate 10-watt station, while Plan 3 includes equipment necessary for a 250-watt station.

Pictures taken at Syracuse University's radio center are a feature of the brochure. This center was started 11 years ago and now has its own low-power FM broadcast facilities.

School officials interested in obtaining a copy of this bulletin may do so by writing to Mrs. E. B. York, Advertising Division, General Electric Company, Electronics Park, Syracuse, N. Y.

RADIOACTIVE ELEMENTS COMBAT CANCER

Radioactive isotopes of various elements have been found valuable in combatting cancer, the report states. Radioiodine has been particularly useful as a means for concentrating radioactive attack on certain types of malignancies, and radiophosphorus has helped surgeons to locate hidden tumors during brain operations. Radiocobalt has been found suitable for irradiating certain types of cancer in place of the vastly more costly radium.

These uses of radioactive elements have been made under the urge of immediate necessity, even when scientists and medical men are not satisfied with present incomplete knowledge of how they work. To fill in these gaps, physiologists and biophysicists are busy at fundamental researches, using radioisotopes to obtain better pictures of the reactions in such constituents of living matter as the amino acids, the lecithins, and the nucleoproteins. With a better knowledge of what goes on in living cells, both normal and abnormal, they will be able to attack the problems of cancer and other diseases with much more confidence.

Spray-gun, for paint or any sprayable liquid, is a self-contained, 17-pound unit with compressor, motor and gun within a single streamlined housing. This improved sprayer, which operates on household current, will apply one quart of paint in four minutes, operating with about 50 pounds air pressure.

EASTERN ASSOCIATION OF PHYSICS TEACHERS
ONE HUNDRED SEVENTIETH MEETING

Joint-meeting with
New England Biology Teachers Association
and
New England Chemistry Teachers Association
Boston University, Commonwealth Ave., Boston, Mass.
December 4, 1948

10:00 A.M. Greetings, E. O. Holmes, Chairman Chemistry Dept., College of Liberal Arts, Boston University
10:10 A.M. Automatic Sequence Control Digital Computing Machines, Dr. E. P. Little, Cambridge
10:50 A.M. Human Vision and the Spectrum, Prof. George Wald, Harvard University
11:40 A.M. Guided Missiles, Mr. Michael C. Witunski, M.I.T.
12:30 P.M. Luncheon Cafeteria Style, B. U. Commons
2:30 P.M. Apparatus Committee Report, Mr. W. Roscoe Fletcher, Chairman

REPORT OF THE ONE HUNDRED SEVENTIETH MEETING OF THE EASTERN ASSOCIATION OF PHYSICS TEACHERS

Because of the absence of Dr. E. C. Holmes, the Association was welcomed to the University by Dean Taylor.

Prof. Fletcher Watson reported on the beginnings of the New England Science fair to be held again this school year. He said that some 30 schools took part last year and it was hoped that at least three times that number take part this year. (His hopes and the hopes of the New England Science Council were realized.)

The first speaker on the scheduled program was Dr. E. P. Little of Cambridge. He gave a very interesting illustrated lecture on "Automatic Sequence Control Digital Computing Machines."

Dr. George Wald of Harvard, the second scheduled speaker, spoke on "Human Vision and the Spectrum." A summary of his most interesting lecture follows:

VISION AND THE SPECTRUM

PROF. GEORGE WALD

Light, so far as human beings are concerned, may be defined by the limits of human vision. The limits of wavelength to which the human may respond depend on the light to which the receptors are permitted to be exposed and the wavelength to which they are sensitive. There are two groups of receptors: rods and cones. The rods provide vision in dim light and the cones provide vision in bright light and interpret color.

The sensitivities of both these receptors are modified by extraocular filters and by the intraocular structures which may have colors or may have special transmission or absorption bands in the spectrum. This report concerns itself with the intraocular structures.

The lens in the human is slightly yellow in color and therefore modifies the usual daylight or artificial light that is to be transmitted. The cornea and the humors absorb certain wavelengths in the violet and the ultra violet region. The retina has a yellow pigment concentrated in a diffuse central zone about the fovea, the macula lutea. This yellow zone in the retina imposes special differences in the spectral sensitivity upon the central as compared with the peripheral retina. The discussion today concerns itself with the spectral sensitivities of foveal cones and of rods well outside the macula lutea. To these are added some

functions not previously mentioned today: spectral sensitivities of peripheral cones and of rods and cones in the aphakic (lens-less) eye and also differences in the sensitivity of both central and peripheral cones of both the normal and the aphakic eye.

Foveal Cones

All measurements were made on the dark adapted eye. The maximum sensitivity of the fovea was found at 562 mμ and the sensitivity declined on both sides to about 1/10,000 of the maximum at 750 mμ and about 1/40,000 at 365 mμ.

Peripheral Rods

In a region 8 degrees above the fovea of the dark adapted eye, the rod sensitivity maximum was found at about 505 mμ and at 365 mμ the sensitivity falls to about 1/20,000 and at about 750 mμ the sensitivity is about 1/2,500,000 of the maximum. Below 550 mμ the dark adapted periphery is 100 to more than 1000 times as sensitive as the fovea. Above this wavelength the peripheral and foveal functions draw together, and at about 650 mμ they cross.

Peripheral Cones

The maximum sensitivity of the peripheral cones was found to be at about 550 mμ or about 12 mμ below that of the fovea. Except for a narrow region between 440 mμ and 490 mμ the sensitivity of the peripheral cones is lower than that of the fovea. Above 550 mμ both functions are parallel; throughout this region the fovea is about 2.5 times more sensitive than the cones of a corresponding area of peripheral retina.

Macular Pigment

The macular pigment, as one might expect, lowers the relative sensitivity of the central retina, depending on the transmitted light.

Aphakic Vision—Rods and Cones

With the loss of the yellow lens, the eye gains enormous sensitivity in both the violet and the ultra violet region. As evidence, the average sensitivity of the aphakic eye at 365 mμ is about 1000 times that of the normal eye. These aphakics see in the ultra violet about as they see at 405 mμ, as blue or violet. They, 60 to 70 year old aphakics read the Snellen chart all the way from the top to the bottom when illuminated by 365 mμ and the doctor present cannot even see the chart. They find seats in a crowded room without bumping into either persons or furniture much to the wonder of the persons with normal eyes.

The Lens

Pigmentation of the lens of the old age eye increases so that the average lens transmits only about 15% at 405 mμ and about .1% at 365 mμ.

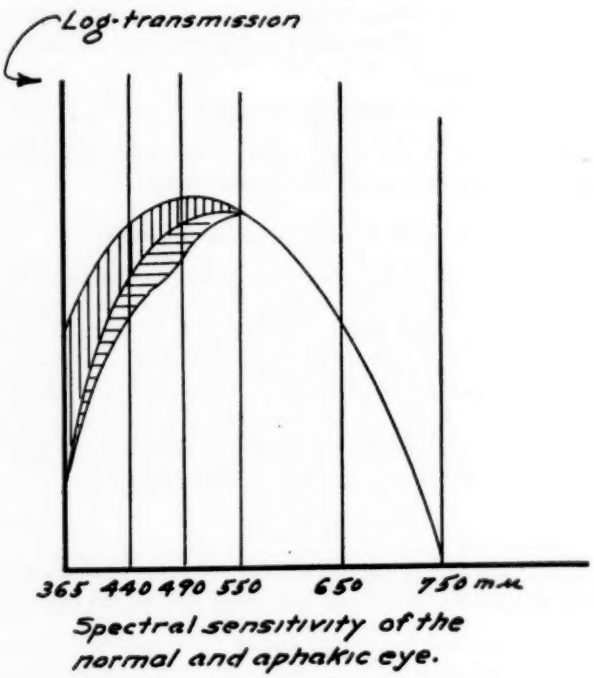
The Table

Concerning the following table: the log′ sensitivity (Log′/threshold) of various wavelengths in a 1 degree circular field, exposed for flashes of 1/25 of a second. Data for foveal cones and peripheral rods and cones of the normal eye are ex-

pressed as relative to the foveal maximum sensitivity. Data for the aphakic rods and cones are presented as relative to their own maximum values.

Wavelength	Log Sensitivity				
	Normal Eyes			Aphakic Eyes	
	Foveal Cones	8 deg. above fovea		8 deg. above fovea	
		Rods	Cones	Rods	Cones
365	−5.401	−2.042	−6.95	−2.62	−2.42
405	−3.806	0.427	−3.64	−1.05	−2.88
436	−2.643	1.675	−2.67	−1.48	−1.22
492	−1.288	2.295	−1.25	0.00	−1.80
546	−1.980	2.095	−1.65	−1.78	0.01
578	−1.966	1.375	−1.59	−1.12	−1.90
621	−1.626	0.038	−1.27	−3.87	−1.63
691	−3.840	−3.635	−3.43	−5.39	−3.87
713	−3.048	−4.787	−4.59	−6.52	−3.11
750	−4.072	−5.890	−5.68	−7.68	−4.18

DIAGRAM



Spectral sensitivity of the normal and aphakic eye.

The spectral sensitivities of cone vision in the normal fovea, and in an area 8 degrees above the fovea in the normal and aphakic eye. All these functions have

been brought together above 578 mμ where all of them are parallel. The horizontally hatched area represents the optical density (Log′/transmission) of the macular pigmentation in the fovea, and the vertically hatched area represents the density of the lens.

The third scheduled speaker, Mr. Michael C. Witumski, brought the Association up to date on "Guided Missiles." A résumé of his talk follows:

GUIDED MISSILES

MR. MICHAEL C. WITUMSKI

On Thursday, Sept. 7, 1944, a German "Sonderkommando" arrived at the Dutch town of Wassenaar, not far from The Hague, ordered all houses vacated, and on the following afternoon the first two of the V-2 rockets were sent against London. The arrival of these two rockets in London, "rang up the curtain" on a new war technique. The era of the guided missile or as the news paper called it "the push button war" was here. From a number of launching places near The Hague some 1027 of these rockets were sent against the British. It is interesting to note that 42% of these launchings were failures for one reason or another.

You have seen both in the daily press and in the newsreel, photographs of the German V-1, the buzz-bomb, and the V-2 rocket projectile. My contribution to the activities here today is to summarize for you the engineering events of a half century and their contribution to the development of the modern guided weapon.

The mission of the guided missile is to carry itself and a pay load over a three dimensional flight path to a predetermined destination aided only by an outside control. Each control may be set before the take off or corrected while in flight by any of several remote control devices.

Guided missiles may be of use for the elimination of an enemy through the use of nuclear weapons, bacterial warfare, or poison attacks. It would be incorrect to see guided missiles only associated with human insanity. They also offer possibilities for peaceful applications. They are of value in scientific research. There is a possibility of travel for both persons and freight over great distances at unheard of speeds.

CLASSES OF GUIDED MISSILES

The term missile does not of necessity imply an act of hostility, it is merely used to cover or give a name to two distinct lines of development: one development is the projectile as the slug from a .45, the other is the aircraft such as the modern air transport. The difference in these two extremes is not so much the manner in which the flight is begun but rather the altitude, the shape of the trajectory, and the speed.

To cover a wide range, the projectile flies along a curved trajectory, rising to a high elevation and then descending to the place of destination. A large part of the flight may be at supersonic velocities and at altitudes in which the air density is small. The aircraft on the other hand, makes use of the lift from its several airfoils, its trajectory is essentially "flat," and its velocity is or has usually been sub-sonic.

Between the two above classes of missile is the hybrid "a winged projectile."

It combines the high trajectory of the projectile with the flat path of the aeroplane.

Projectiles may be the shell or bullet type or the self-propelled type. Both may rightly be called guided missiles, both may have fins for stability, and both may have control devices.

Similar distinctions are to be found in the aircraft type. The glider bomb relies entirely on gravity for propulsion while the aerial torpedo flies under its own power.

There is a further, more subtle, differentiation between "guided" and "directed." Guided implies a preset flight path while directed implies that flight may be selected after take-off. In point of fact, modern missiles are guided as well as directed.

The idea of guided or directed missiles is not new. Jules Verne, writing in or about 1880, describes a rocket projectile with a target seeking device, a proximity fuze, with an explosive of extreme blast effect and, strange to relate, it launches itself following a chemical reaction. An advertisement in the *Engineer* of May 1896 tells of a flying bomb, operated by steam, having control surfaces, to carry a ton of explosive and claimed to be the "only way to destroy an enemy without danger to the attacker."

Patrick Y. Alexander, read a paper at London in 1901, entitled "On Sounding the Air by Flying Machines Controlled by Hertzian Waves." He predicted a speed of 1000 miles per hour.

The flying bomb of the German V-1 type is hardly of World War II vintage for a French artillery officer, Réné Lorin, described the design in great detail in 1910. He had begun work on it in 1907. In 1915 he suggested to the French authorities that his "torpille aerienne" should be employed to bomb Berlin, a number of hundred kilometers from the French positions. The propulsion of his missile should be by aero-thermal ducts (athodyds). This is now known as the Lorin Duct. The missile was to be catapulted, an immense advantage over French, British and American experiments conducted at a later date. The design was turned down as fantastic and he published the details in May 1918. Lorin suggested control of his missile by means of radio waves. A German school teacher, Wirth, in 1913 and 1914 demonstrated a radio controlled model aircraft in a Berlin circus.

Gyroscopic stabilization, suggested by Lorin, was demonstrated in France in June 1914 when a Curtis flying boat equipped with an early form of the automatic pilot designed by the American E. A. Sperry was successfully flown. There were official observers. Except for the Lorin tube, all the elements of his "torpille aerienne" were available in practical solution.

The British Effort

A. M. Low approached the British authorities in 1915 with plans for a radio controlled biplane. Much work was done but the model biplane came to grief.

Between 1917 and 1918 hundreds of flights were made by crewless biplanes and monoplanes in the greatest of secrecy. The biplanes worked best launched from rails. The monoplanes were best launched from catapults mounted on a lorey. The airplanes were controlled from the ground, only a single control at a time, maneuvering was sluggish and difficult.

When the V-1 buzz bombs on London demonstrated that a new era of warfare was at hand, some American papers published a photograph of a pilotless biplane, by U. S. Navy and Sperry Corp., on a launching track with the caption "Worlds First Flying Bomb." The picture was taken at Bellport, Long Island in 1918. Although the idea to provide an auto-pilot is due to Lorin, the Sperry Corp. of U. S. was best fitted to tackle the problem.

The origin of this development may be in England where it was thought that such a missile should take-off by itself or by catapult, climb to a preset height, level out automatically, and maintain a straight path. All this was brought about by two electrically driven gyroscopes, one monitored by aneroids and the other to keep the course straight. A range determinator or "air log" was incorporated which registered the distance flown. The similarity of this device with that of the V-1 is quite apparent.

German Guided Missiles

The wireless experts of the German Air Force recalled, in 1916, the demonstrations of the school master Wirth at the Berlin circus. Wirth, who tried to sell his ideas in vain, was asked to fit his device to full sized unmanned aeroplanes. The firm Siemens and Halske was invited to cooperate with Wirth. The Siemens engineers had better ideas and the unsuspecting school master was bid farewell. Wirth's ideas were exploited and triode vacuum tube amplifiers were used to operate the controls. The use of the triodes was possibly the only new idea furnished by Siemens.

Before an airplane equipped with suitable instruments could be flown, the war came to an unexpected end and all experimental evidence was made to disappear.

In 1918, Anthony Fokker described a small glider to be towed by an airplane over enemy lines and then released. It was the first glide bomb ever made. It was to be in mass production some time in 1919.

Clandestine Experimentation

The Versailles Treaty specifically prohibited the operation of remotely controlled unmanned aeroplanes by the Germans. After the Ruhr was occupied the German Government authorized research. The German Army Air Staff entertained the idea that fast unmanned aircraft could be used for photographic reconnaissance and might even be useful for strategic bombing. When Franz Drexler presented his automatic pilot and radio control in 1926, he had little difficulty in getting an audience. The Army went along with the Drexler-Dickmann method of control and the Navy made use of proposals by Boykow. Experiments went ahead with large model aeroplanes for anti-aircraft practice. During much of the discussion General Karl Becker was present and he promoted the idea of a self-propelled projectile in place of the pilotless aeroplane.

Much electronic experimentation in control of flight from the ground resulted in "ghost" boats on Lake Ammersee in Bavaria. These caused no small consternation among visitors at the lake and among the fishermen.

Flight-stage of the development was reached in 1929, Drexler dies of influenza. In 1931, a seaplane was operated successfully entirely by remote control, Siemens, who stole from the school master, took over and Boykow died. Siemens

was apparently a laboratory interested in Soaring Flight by this time but, actually was an instrument laboratory for the Nazi Air Ministry.

During the last of the above, much work was being done to develop the V-1 or buzz bomb. The two main collaborators, Nebel and Riedel, began to disagree in the manner in which research was to continue. Some rockets were launched but they meandered over the country side and some disintegrated in the air. This was not good publicity. One rocket reached an altitude of 33,000 feet in August 1931. This rocket was demonstrated before the military and returned to the earth safely by parachute. This was really the first experiment in connection with what was to be the V-2.

Other Developments

About this time, there sprang up many societies scattered through the world, interested in rocket travel—even to the other planets. It was suggested to the British authorities that liquid fuel rockets should be investigated in 1934 in view of the German developments but the Ministry stated that jet propulsion could be no serious threat to the air-screw.

There is no need to provide a detailed description of the V-1 flying bomb—it is a normal monoplane minus the usual controls. It has three air driven gyroscopes. It is controlled in azimuth by a monitoring magnetic compass. There is a wind mill air-log to control the range. Some of the V-1 projectiles were to be manned by special suicide pilots who were to play "Goetterdaemerung." Ailerons were provided on this version. About 250 of these suicide V-1's were on order but called off in 1944.

The V-1 was launched by a steam operated catapult about 157′ long. Steam was produced by concentrated hydrogen peroxide on calcium permanganate, the Walter catapult. By the end of the catapult the velocity was 245 miles per hour, 185 miles per hour was needed to start the ram jet efficiently. About 14 percent of the missiles came to grief immediately after launching.

In the meantime, other progress had been made, beginning in 1935, when about 175 million dollars was invested in what delighted Hitler—the design and completion of a 1000 mile rocket. The experimental work for this rocket was at Peenemuende. Peenemuende is now in Russian hands and hence the continuous quarrel with Denmark over the domination of the nearby island of Bornholm.

Goering was not to be outdone by the army at Peenemuende, he asked Eugen Saenger, of Vienna, to start investigations in 1936 at Tranen. Saenger's long time research program was more impressive than the over optimistic policy of the army technicians, which was based on the work of the Rumanian grammar school teacher, Oberth. The Traenen establishment was closed in 1942, Goering saw no need to compete for Peenemuende had had such discouraging results.

The design of rockets continued and, curiously enough, every time the design deviated from that suggested by Oberth twenty years before, it proved unsuccessful.

Peenemuende, the V-2

Experiments with the final version of the V-2 began in July 1942; in October 1942 the first successful launching was made. The fourth rocket flew 170 miles. Quantity production was started and in one underground plant 30,000 workers

and 25,000 machine tools completed 30 rockets a day. Up to October 1944, 12,000 V-2 rockets were constructed in order to deliver 1000 rockets a day to bring England to her knees.

Reconnaissance by the RAF in 1943, located the rockets and they were "treated" by bomber command. Great damage was done. The large research establishment at Volkenrode was never discovered.

The launching procedure is of the greatest importance for the success of the weapon. The Dutch observers found that there were no failures when the launching took place in clear, dry and sunny weather. The V-1 could be launched in any weather. U. S. has had good luck with the launchings—even from the deck of a ship under way.

On one occasion, German staff officers were starting out to sea to witness the descent of a demonstration V-2. They heard the detonation of the descending rocket *behind* them. It had a most undesirable effect on the officers. In the end, General Becker, who was responsible for the development, committed suicide.

General Becker has been forgotten by the Germans as well as the Rumanian grammar school teacher, Oberth—"all German rocket research workers have been careful not to mention Oberth at all although all the features of the V-2 and similar Peenemuende developments—were actually based on suggestions and investigations made by him—he was the first to investigate and prove the advantages of winged rockets for long distance bombardment."

World-Wide Efforts

The rocket is the only means of propulsion outside of an atmosphere. We are still far from the dreams of the "astronauts," space travelers, recognition must be given to much valuable aid they have provided in the solution of many rocket problems.

Much credit is due, in the first place, to the Russian school master Constantin Eduardowitch Ziolkowsky (1857–1936). He propounded the necessity of large rockets for space travel in 1896. He suggested liquid fuels in 1898.

The Russians were not only interested in space ships but had military uses in mind in their rocket design. General Pomortzeff suggested a rocket propelled trench mortar missile having a stabilizing ring in front of the discharge port. D. Riabouchińsky devised such a missile in 1916, the prototype of the American "Bazooka" or the German "Panzerfaust." It is also interesting to note in connection with the V-2 development and the Russian developments that A. B. Schersschewsky was not only a pupil of Ziolkowsky but also one of the able assistants of Oberth.

Ziolkowsky suggested liquid fuels in 1898 and in 1914 specified that they should be liquid gases for extreme altitudes and liquid oxygen with alcohol-water mixtures for lower altitudes. Indeed such a fuel is used in the V-2.

The step rocket was suggested by Oberth in 1923, alcohol-oxygen was the fuel for the initial rocket and liquid hydrogen with liquid oxygen was used in the final step. He published these suggestions but little attention was given to them at the time. He started some experimenting with small step rockets, with some success but was unable to proceed to the really large sizes he had planned. He returned to his grammar school.

Little practical work has come from France but in U. S. Robert H. Goddard has experimented with rockets for extremely high altitudes since 1909. He has proved that the rockets have a higher thrust in a vacuum than in the atmosphere. In 1919 he startled the world by suggesting that a rocket to the moon was within the realm of possibility. His work has been of value to the development of war rockets in U. S. He died in 1947. It is a fact that we have been handicaped in the development of extreme altitude rockets until the German achievements were disclosed. However the practical solution to long distant control of flight of planes has been adequately demonstrated, witness the over ocean flight of the Skymaster during the summer of 1947. A complete trans-Atlantic crossing, take-off and set-down controlled entirely from the ground. The pilot in the ship did set the brakes after landing on the runway in England.

A guided missile in the form of a plane can be sent to any spot in the world by the American "know how" but the radio control can be jammed.

Work in the U. S.

Some of our successes follow: the N.A.C.A. "Tiamat" two step rocket reaches 600 miles and is employed for homing research. The Douglas "Corporal" has reached an altitude of 50 miles. Caltech has a stabilized rocket used to test airfoils, the U. S. Army has a test beam guided rocket for high altitudes. A guided missile actually used in the late war is the 2000 pound glide bomb, Mark GB-8, a winged missile carried by the Flying Fortress. The late models have radio control for range and deflection. They were used against the U-boat pens on the French coast, against Cologne, Salzburg and Düren. The 1000 pound radio controlled bomb "Azon" is a wingless projectile having control surfaces on the tail. "Weary Willy" a stripped down expendible B-17 or B-24, was loaded with 2000 pounds of explosives, flown near the target by a pilot who then bailed out. The rest of the flight was radio controlled. They were used in "treating" the V-2 launching sites. Northrop has flown a number of flying wing buzz bombs with success. The U. S. Naval Air Missile Test Center has done much with 9″ pulse jet ducts, athodyds and improved German missiles. The U. S. Navy uses "Queen Bees" for training AA gunners. The U. S. Navy and the U. S. Air Force has "Drones" used to simulate high-level bombing runs, dive bombing attacks an low-level torpedo runs and evasive tactics. They are used for AA practice. The U. S. Navy has the "Kaydid" operated by a 7″ duct engine, used for AA practice. The target is recoverable for a parachute lowers the "Kaydid" and shuts off the engine by radio control. The U. S. Navy "Bat" was used against the Japanese shipping. It has a radar pulse scanner for a homing device. No propulsion or radio control is needed for it is dropped from high levels. The U. S. Navy "Little Joe" is a cross winged projectile. There are four main rockets and one launching rocket. It incorporates a proximity fuse. The newer versions, developed after V-J day, is radio controlled. The "Gargon," a U. S. Navy winged guided missile is extensively used as a test vehicle. It is sub-sonic and has been used in experiments with athodyds.

Attend the 49th Annual Convention of the Central Association of Science and Mathematics Teachers at Chicago, November 25 and 26.

EASTERN ASSOCIATION OF PHYSICS TEACHERS
ONE HUNDRED SEVENTY-FIRST MEETING

Saturday, March 12, 1949
Northeastern University, Boston 15, Massachusetts

10:00 A.M. Greetings by an officer of the University
10:15 A.M. Address: "The Teaching of Physics at Northeastern," Dr. Reginald G. Lecount, Chairman of the Physics Dept.
10:50 A.M. Address: "Television—Present and Future," Mr. Hollis S. Baird, Instructor in the Physics Dept.
12:00 noon Luncheon—Northeastern has no dining room. It is suggested that we may find the restaurant "Le France" convenient to use.
1:00 P.M. Business Meeting
2:00 P.M. Report of the Apparatus Committee

Northeastern University is located at 360 Huntington Avenue.

Electric cars leave Park Street Station of the MTA about every five minutes. for those who drive, there is adequate parking space available at the regular University parking area.

REPORT OF THE ONE HUNDRED SEVENTY-FIRST MEETING OF THE EASTERN ASSOCIATION OF PHYSICS TEACHERS

The 171st meeting of the Eastern Association of Physics Teachers opened promptly at 10:00 A.M. March 12th, 1949 at Northeastern University with greetings from Dean William White in the absence of the president of the university. Dean White expressed the most hearty welcome and recalled that it has been some years since the EAPT has visited Northeastern. The Association was told that Northeastern has an interest in the EAPT for 4000 full time students and 7000 part time students represent some of the work of the high school physics teachers.

The first scheduled speaker on the program, Dr. Reginald G. Lecount, Chairman of the Physics Department at Northeastern, spoke on "The Teaching of Physics at Northeastern University."

Dr. Lecount first indicated on the black board the time schedule of the pupils in the five year program. There are two divisions in all the classes called A and B. While A is in school, B is out in the engineering world getting practical experience, and it must not be forgotten, pay for services rendered.

In the five years there are 130 work units in the place of the 120 work units in the conventional college. This is a distinct advantage.

Some eighty percent of the student body are in pre-engineering courses and the other twenty percent are in liberal arts, medical and dental courses. These last twenty percent of the student body take a basic course in physics.

The major physics course takes two college years: the freshman and the sophomore years. The freshmen begin with mechanics, electricity and magnetism. The analysis of problems is stressed and an effort is made to discover the principles involved rather than to just learn the formulas. Kirchoff's Laws are covered very thoroughly. The last weeks of the first year are spent in alternating current and thermionics.

There are two lectures per week and tests are given during the lecture time. In addition to this there are section meetings where the problems of the week are reported on. During the section meetings, pupils are called on by name to recite and any particular trouble in the group is brought to a head and straightened out. There is no laboratory the freshman year.

In the sophomore year, things move at a faster pace for by now all have had the calculus. Light, heat and sound are covered very carefully. The laboratory work of the sophomore year covers both years of the course. A book, loose-leaf type, printed at Northeastern University, entitled "An Introduction to Experimental Physics" by Welch is used. Answers are written on blanks on the loose-leaves in order to get more done and save copying time.

All laboratory work is done with really good equipment. It is the desire to get a good quantitative product and not have rough qualitative work. Accuracy is very important. The student must be familiar with the principles involved before he is permitted to do the laboratory work. About one fourth of the year's work is in the laboratory.

All the examinations are made at Northeastern University and consist of the multiple choice type of item. It is believed better to test extensively on much material rather than intensively on ten samples of the work.

The pre-medical students take a one year course with special attention to certain phases of heat, sound, light, electricity and magnetism.

Above the sophomore year all science majors must take physics. All preceding work is assumed to be known and no time is spent on past teaching.

The courses available include:

Spectroscopy
Electronics
The electron tube
Electricity and magnetism
Parallel AC circuits
Transients
AC machinery
Electrical measurements and
Communication

In the graduate school, such courses as the following are available:

Physical optics
Modern physics
Accoustics and
Heat

There is one man in the department for each of these courses.

The second speaker on the program was Mr. Hollis S. Baird. He spoke most interestingly on "Television—Present and Future." His lecture was profusely illustrated with slides both of early, present and experimental equipment.

There are many problems connected with television and not all of them are electrical. Television is at present cutting into both newspaper and magazine advertising. The radio audience is getting smaller and therefore the radio industry must eventually cut its advertising fees to sponsors. The movies are beginning to feel the loss of audience to television.

There is one big sociological factor that is of importance in connection with television: it is bringing or tends to bring the family back into the home.

The electrical problems are another matter. Only twelve channels are available today for television as against 100 channels for sound.

Because we desire a 525 line picture having no flicker and good definition, a large segment of the electromagnetic spectrum allotted to communications must be used by each station. This means that no or very few cities will ever have more than 4 or 5 stations. It is possible to go to higher frequencies which are still available but there the electronic and electrical problems are not satisfactorily solved. The frequencies between 480 and 920 megocycles are assigned to television but these are several years away.

The financial problem is of importance too, but as yet it is not how much the station nets per day but how little can it lose. At present the best seems to be in the order on magnitude of $1000 per day.

During the report of the apparatus committee, Mr. fletcher pointed out that elecution classes have value even in the physics classes, all speaking in the class should be in such a manner that all can hear with the minimum effort.

One of Mr. Fletcher's students told the Association of the battery works he visited at Easthampton, Mass. The Nicad battery is made there.

Mr. Fletcher demonstrated Melde's experiment with vibrating strings. The

following is a copy of his laboratory experiment sheet for this experiment:

Date_____ Name_____ No._____

Vibrating Strings (Melde's experiment)

To produce "stationary" waves in order that we may study:

1. Effect of tension on the number of segments,
2. Compute the frequency of the vibrating source,
3. Compute the velocity of waves in the string.

An understanding of the following terms is needed:
node, antinode, stationary wave, resonance, phase, direct and inverse proportion.

Notation used: V, velocity of waves in string; λ, wave length; L, length of string; N, number of segments; f, frequency; δ, density; m, mass per unit length; T, tension.

Stationary waves may be set up in a string vibrating in resonance with the vibrating body connected with it. Nodal points are points where the incident and reflected waves are at all times in opposite phase; and at the loops they are in phase. The waves travel back and forth in the string with a velocity:

$$V=\sqrt{\frac{T}{m}}.$$

The impressed frequency may be found from the relation:

$$f=\frac{N}{2L}\sqrt{\frac{T}{m}}=\frac{N}{2L}\sqrt{\frac{T}{\pi r^2\delta}}.$$

In our experiment we shall attempt to show that:

$$N\propto\frac{1}{\sqrt{T}}.$$

Many other experiments (57 in all) involving 2, 3, 4, 5 & 6 variables at a time could be improvised to test this law of vibrating strings. Make a list of 15 possible variations involving 2 independent variables.

$$N\propto\frac{1}{\sqrt{T}}.$$

$$N\propto fT \text{ etc.}$$

To perform the experiment, attach an elastic string (120 to 140 cm. long) to a vibrating body. Run the other end of this string over a pulley, and to this end attach the variable weights. Vary the frequency of the body and the length of the string so that under a tension of 50 grams (49,000 dynes) four clear cut segments may be obtained. Compute $T(N\propto 1/\sqrt{T})$ tension required to produce 8, 7, 6, 5, 4, 3, 2, and 1 segments. Test by recording the experimental results required to produce the same number of segments. Finally, find the mass per unit length of the string.

Data needed:

	8	7	6	5	4	3	2	1
1. No. of segments								
2. Length of string (cm)								
3. Length of wave (cm)								
4. Tension computed (dy)								
5. Tension used (dy)								
6. Mass/Length (g/cm)								
7. Freq. of source (vps)								
8. Velocity of wave (cm/sec)								

Diagram the apparatus used and show how formulas are obtained on the back of this sheet.

The following demonstrations were presented at the one hundred seventieth meeting at Boston University on December 4, 1948.

The Differential Pulley

A number of pulleys, for example, 2, 4, 6 and 8 inches in diameter are mounted on the same shaft and in contact with one another. All the pulleys are fastened together. Two single pulleys are threaded with an endless string as shown in the figure. See Figure 1. The string may pass over any two of the upper pulleys and weights may be attached to the two lower pulleys. This makes a very interesting piece of demonstration apparatus.

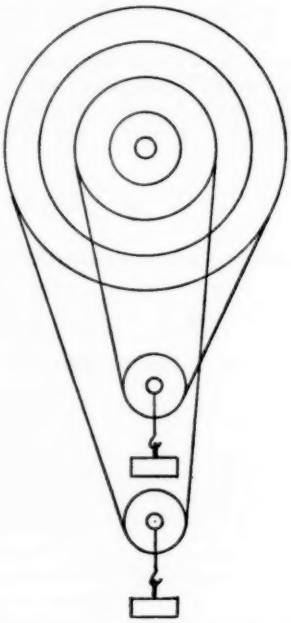


FIG. 1

The Plastic Aspirator

The action of fluids in an aspirator may be shown by means of the plastic aspirator and the projection lantern as shown in Figure 2. The aspirator is upside-down on the screen but the physics class should have little difficulty on this score. The construction of the aspirator is quite apparent from the figure. It is necessary, of course, to remove the bellows from the projection lantern if the usual lantern is used. There is little need to use the regular projection lantern. A large electric lamp, suitably shielded may be used as a light source. A piece of frosted glass may be used in the place of the condenser as shown in Figure 3. The distance between the projection lens and the model of the aspirator depends on the focal length of the projection lens. The distance is slightly more than the focal length of the projection lens used. The common reading glass works well as a projection lens. The set-up is shown in Figure 3.

The Ball Has a Curve

The curve on a ball may be demonstrated by means of a common ping pong ball and a mailing tube. The inside diameter of the mailing tube must be greater

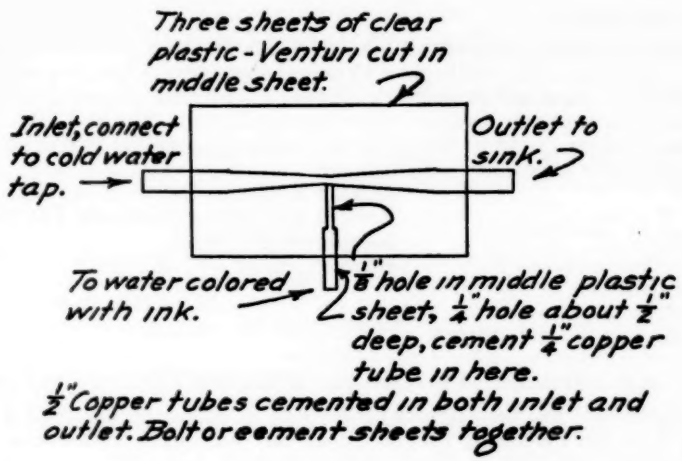

Three sheets of clear plastic - Venturi cut in middle sheet.
Inlet, connect to cold water tap.
Outlet to sink.
To water colored with ink.
⅛" hole in middle plastic sheet, ¼" hole about ½" deep, cement ¼" copper tube in here.
½" Copper tubes cemented in both inlet and outlet. Bolt or cement sheets together.

FIG. 2

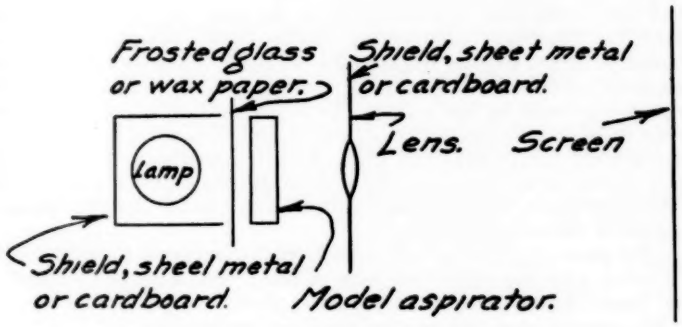


FIG. 3

than the ball so that the ball may roll freely. The mailing tube may be any amount larger than the ball. The size is limited only by the inconvenience in using the tube as a throwing mechanism. Place the tube up-right in the hand, drop the ball into the tube, lower the tube nearly to the horizontal, swing or sling the tube quite quickly and do not let the tube free. The ball will be projected from the tube at a high velocity and it will have a very fast spin, due to the fact that it rolls very rapidly from the tube. The ball will curve plenty. Range, trajectory and azimuth are not dependable. Be sure that the pupils are agile or have plenty of free space.

The Action of Stops

The action of stops on the working of a lens as indicated by the "*f*" value on the camera may be shown by means of a large, clear, not frosted, electric lamp, a few pieces of paper, and a common reading glass. Arrange the lamp and lens so that the inage of the incandescent filament is projected on a suitable screen. Make a hole in a piece of paper one half the diameter of the lens. Place this paper so that it is centered and in contact with the lens. The image on the screen will be sharpened somewhat. Use smaller and smaller stops and see the increased sharpness of the resulting image. Spherical and chromatic aberration may be shown by decentering the stops.

Action and Reaction

Stand or crouch on a board mounted on two rolling pins or two short sections of 2 or 3 inch pipe. Try to throw a 16 pound shot (see the track coach) nearly horizontally in the direction in which the board is pointed. Be prepared for a fall or at least be ready to readjust your own equilibrium. The ball will "sail" a surprisingly short distance. You will roll backwards, still up-right and on the board the writer hopes, for some distance.

ALBERT R. CLISH, Secretary and Treasurer
Eastern Association of Physics Teachers
Belmont High School,
Belmont, Mass.

A NEW IDEA IN ELECTRONIC ENGINEERING INDEXING

Announcement has been received from John F. Rider, president of the Electronics Research Publishing Co., Inc., that the Electronics Engineering Master Index for 1947 and 1948, and the index for January-June 1949 will be published during November 1949.

Of utmost significance to the electronic engineering industry, which uses these indexes, is the institution of a new idea in the contents of these publications. Heretofore, the Electronic Engineering Master Index contained references only to published technical papers. Beginning with 1947–1948 index, the contents will cross reference published technical papers and related U. S. Patents allowed during the period covered by the volume. Thus the electronic engineering industry will have available a single source listing all technical articles published in the U. S. and abroad during 1947 and 1948, the titles, patentee, serial number, and number of claims, of all electronic and related-subject patents issued in the U. S. during the same years. This program will be carried out in the 1949 index and all future issues of these publications.

Of equally great significance to the electronic engineering fraternity is the fact that beginning with the 1947–1948 issue of this index, a list of technical articles available from sources other than regularly published publications will be included. We are sure that this service will be of tremendous aid to all interested personnel because many very valuable articles and papers which were born of technical research during World War II never were printed in the usual run of publications. The full identification of the title, author and source will be included.

A STUDY OF ARTHRITIS AND RHEUMATISM AT WISCONSIN

An intensive study of arthritis and rheumatism will be initiated at the University of Wisconsin as the result of a gift of $10,300 from the Thomas E. Brittingham trust fund.

Dr. D. M. Angevine and Dr. C. H. Altshuler of the department of pathology, who have been conducting histo-chemical studies of rheumatic disease for the past two years, will receive $5,300 to finance their work.

Four thousand dollars will be used for electromyographic apparatus for the study of muscular changes in arthritic conditions. Dr. Harry Bauman of the department of physical medicine, an authority on muscle physiology, will be in charge of the study.

Dr. C. V. Seastone of the department of microbiology, who has worked on streptococci infections for many years, will use $1,000 of the gift to investigate sensitization reactions to streptococci in rheumatic and arthritic states.

RECOMMENDED REVISION OF THE BY-LAWS

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

Present Articles and Sections to be Amended

I. MEMBERS

SECTION I. QUALIFICATIONS: Any teacher concerned in the teaching of science or mathematics is eligible for regular membership in this association. Any person, firm, or corporation, interested in any aspect of the teaching of science or mathematics shall be eligible for associate membership in this association.

SECTION IV. DUES: The annual dues of each member of the association shall be $2.50 payable in advance. The annual dues shall also entitle the member to receipt of the Journal or other publication of the association.

SECTION V. VOTING: Each regular member of the association shall be entitled to one vote. Associate members shall be entitled to attend all meetings of the association, but shall not be entitled to vote.

III. OFFICERS

SECTION I. OFFICERS: The officers of this association shall be a President, a Vice President, a Secretary and a Treasurer. One or more Assistant Secretaries and Assistant Treasurers may be appointed by the President.

SECTION II. QUALIFICATIONS: The President and Vice President shall be members of the Board of Directors.

SECTION III. ELECTION, TENURE OF OFFICE, COMPENSATION: The President and Vice President shall be elected by the members of the association at the annual meeting and shall serve for a term of one year or until their successors are elected. All other officers shall be elected by the Board of Directors at a meeting to be held following the annual meeting of the association and shall serve for a term of one year or until their successors are elected. The compensation of the officers, if any, shall be fixed by the Board of Directors.

Suggested Revisions (Deletions are bracketed; additions are italicized)

I. MEMBERS

SECTION I. QUALIFICATIONS: [Any teacher concerned in the teaching of science or mathematics is eligible for regular membership in this association.] Any *teacher or other* person, firm, or corporation, interested in any aspect of the teaching of science or mathematics shall be eligible for [associate] membership in this association.

SECTION IV. DUES: The annual dues of each member of the association shall be [$2.50] *$3.50*, payable in advance. The annual dues shall [also] entitle the member to receipt of the Journal [or other publication of the association.]

SECTION V. VOTING. Each [regular] member of the association shall be entitled to one vote. [Associate members shall be entitled to attend all meetings of the association, but shall not be entitled to vote.]

III. OFFICERS

SECTION I. OFFICERS: The officers of this association shall be a President, *a President-Elect*, a Vice President, a Secretary, a Treasurer *and Business Manager, an Editor of the Journal, and an Historian.* One or more Assistant Secretaries and Assistant Treasurers may be appointed by the President.

SECTION II. QUALIFICATIONS: The President, *the President-Elect*, and the Vice-President shall be [members of] *nominated from* the Board of Directors.

SECTION III. ELECTION, TENURE OF OFFICE, COMPENSATION: The *President, President-Elect*, and Vice President shall be elected by the members of the association at the annual meeting and shall serve for a term of one year or until their successors are elected. *The Treasurer and Business Manager, Editor of the Journal, Historian, and Secretary shall be elected by the Board of Directors at a meeting to be held following the annual meeting of the association,*

Present Articles and Sections to be Amended	*Suggested Revisions* (Deletions are bracketed; additions are italicized)
	and shall serve for a term of three years. Their terms may be renewable. All other officers shall be elected by the Board of Directors at a meeting to be held following the annual meeting of the association, and shall serve for a term of one year or until their successors are elected. The compensation of the officers, if any, shall be fixed by the Board of Directors.
SECTION IV. POWERS AND DUTIES OF OFFICERS: (a) PRESIDENT: The President shall preside at all general meetings of the association and shall perform the usual duties of his office. He shall be chairman of the Board of Directors and chairman of the Executive Committee, and shall perform the usual duties of those offices.	SECTION IV. POWERS AND DUTIES OF OFFICERS: (a) PRESIDENT: The President shall preside at all general meetings of the association and shall perform the usual duties of his office. He shall be chairman of the Board of Directors and chairman of the Executive Committee, and shall perform the usual duties of those offices.
	(b) *President-Elect: The President-Elect shall be considered as the successor to the Presidency. He shall act for the President in the latter's absence. He shall be a member of the Board of Directors and Executive Committee and shall work closely with the President to familiarize himself with matters of policy and procedure.*
(b) VICE PRESIDENT: He shall act for the President in the latter's absence.	(c) VICE PRESIDENT: He shall act for the President [in the latter's absence.] *or President-Elect in event of the absence of either. He shall also be a member of the Executive Committee.*
(c) SECRETARY: The Secretary shall keep all records, minutes of all meetings and shall prepare and submit a complete report of the annual meeting to the Editor of the Journal by December 31st following the meeting.	(d) SECRETARY: The Secretary shall keep all records, minutes of all meetings and shall prepare and submit a complete report of the annual meeting to the Editor of the Journal by December 31st following the meeting.
(d) TREASURER: The Treasurer shall collect all dues and hold all moneys and keep a record of all receipts and disbursements. He shall give a detailed report at each meeting of the association. He shall pay out funds on the order of the Board of Directors and the Executive Committee.	(e) TREASURER *and Business Manager:* The Treasurer *and Business Manager* shall collect all dues and hold all moneys and keep a record of all receipts and disbursements. He shall give a detailed report at each meeting of the association. He shall pay out funds on the order of the Board of Directors and the Executive Committee. *He shall also act as Business Manager of the Journal, in cooperation with the Editor.*
(e) EDITOR AND BUSINESS MANAGER: The Editor and Business Manager of the Journal shall be elected by the Board of Directors. Their term of office shall be indeterminate at the	(f) EDITOR [AND BUSINESS MANAGER] *of the Journal:* The editor [and the Business Manager] of the Journal shall be [elected by the Board of Directors] responsible for the Journal. [Their

Present Articles and Sections to be Amended	*Suggested Revisions* (Deletions are bracketed; additions are italicized)
pleasure of the Board of Directors.	term of office shall be indeterminate at the pleasure of the Board of Directors.]
	(g) *Historian: The Historian shall be charged with the responsibility of collecting and preserving the historical documents of the association.*
IV. Board of Directors	IV. Board of Directors
Section II. Number: There shall be fifteen (15) members of the Board of Directors. The President, the Vice President, and the President of the preceding year shall be ex-officio members of the Board of Directors. The remaining members of the Board of Directors shall be divided into three groups of four (4) directors each. Four directors shall be elected annually to succeed those of the group whose terms are about to expire.	Section II. Number: There shall be [fifteen (15)] *twenty (20)* members of the Board of Directors. The President, the Vice President, the President of the preceding year, *the President-Elect, the Secretary, the Treasurer and Business Manager, the Editor of the Journal, the Historian* shall be ex-officio members of the Board of Directors. The remaining members of the Board of Directors shall be divided into three groups of four (4) directors each. Four directors shall be elected annually to succeed those of the group whose terms are about to expire.
Section IV. Election, Tenure of Office and Compensation: Directors shall be elected by a majority vote of the members present at any annual meeting. They shall assume the duties of their office immediately preceding the adjournment of the annual meeting and shall serve for a period of three years or until their successors are elected. They shall serve without compensation, except that they may be allowed a reasonable compensation for traveling, and necessary expenses incurred by them in the discharge of their official duties.	Section IV. Election, Tenure of Office and Compensation: Directors shall be elected by a majority vote of the members present at any annual meeting. They shall assume the duties of their office immediately preceding the adjournment of the annual meeting and shall serve for a period of three years or until their successors are elected. They shall serve without compensation, except that they may be allowed a reasonable compensation for traveling, and necessary expenses incurred by them in the discharge of their official duties.
Vacancies in the Board of Directors may be filled by the Board of Directors at any meeting thereof. The directors so chosen shall serve for the unexpired term of the director whom he succeeded.	Vacancies in the Board of Directors [may] *shall* be filled by the Board of Directors at any meeting thereof. [The directors] *A director* so chosen shall serve for the unexpired term of the director whom he succeeded.
Whenever directors are elected, whether at the expiration of a term or to fill vacancies, a certificate under the seal of the association giving the names of those elected and the terms of their office shall be recorded in the office of the recorder of deeds where the certificate of organization is recorded.	Whenever directors are elected, whether at the expiration of a term or to fill vacancies, a certificate under the seal of the association giving the names of those elected and the term of their office shall be recorded *by the Treasurer and Business Manager* in the office of the recorded of deeds where the certificate of organization is recorded.
Section VIII. Powers and Duties: The Board of Directors shall (1) have general supervision of the activities of	Section VIII. Powers and Duties: *Members of* the Board of Directors shall (1) *have the right to vote;* (2) have

Present Articles and Sections to be Amended	*Suggested Revisions* (Deletions are bracketed; additions are italicized)
the association; (2) authorize the expenditure of funds; (3) fix the salary and bonds of the officers; (4) fill vacancies.	general supervision of the activities of the association; (3) authorize the expenditure of funds; (4) fix the salary and bonds of the officers; (5) fill vacancies.
V. EXECUTIVE COMMITTEE AND OTHER COMMITTEES	V. EXECUTIVE COMMITTEE AND OTHER COMMITTEES
SECTION I. EXECUTIVE COMMITTEE: (a) MEMBERS: Members of the Executive Committee shall consist of the President and two directors chosen by the Board of Directors, and shall serve for one year or until their successors have been elected or appointed.	SECTION I. EXECUTIVE COMMITTEE: (a) MEMBERS: Members of the Executive Committee shall consist of the President, *President-Elect, Vice President, and* immediate past president [and two directors chosen by the Board of Directors] and shall serve for one year or until their successors have been elected or appointed.
SECTION IV. PROFESSIONAL SECTIONS: The association shall be divided into sections as follows: Biology, Chemistry, Elementary Science, General Science, Geography, Mathematics, and Physics. Each section shall be composed of members of the association who are especially interested in the subject of that section. The organization and activities of the sections may be amended from time to time by the Board of Directors. Unless otherwise provided by the Board of Directors each section shall elect its own Chairman, vice Chairman and Secretary.	SECTION IV. PROFESSIONAL SECTIONS *and Groups*: The association [shall] *may* be [divided] *organized* into sections *and groups* as follows: Biology, Chemistry, *Elementary Mathematics*, Elementary Science, General Science, Geography, Mathematics, Physics, *Conservation, Junior College Group, Senior High School Group, Junior High School Group, and Elementary School Group.* Each section *or group* shall be composed of members of the association who are especially interested inthe subject of that section *or group.* The organization and activities of the sections *or groups* may be amended from time to time by the Board of Directors. *Sections or groups may be added, combined, or discontinued by the Board of Directors, as the demand indicates.* Unless otherwise provided by the Board of Directors each section *or group* shall elect its own Chairman, vice Chairman and Secretary.
	Section VII. The Policy and Resolutions Committee: The Policy and Resolutions Committee shall consist of six (6) members. Each member shall serve three years. Two members shall be chosen annually by the President to replace the two whose terms are about to expire. One of those chosen annually must be from the Board of Directors. The President will annually designate the chairman of this committee.

AMENDMENT X. Article 6. Amendments. The By-Laws may be amended by a two-thirds (⅔) vote of the regular members present at any regular meeting of the Association, or at any special meeting of the Association called for the

purpose of voting on such amendment provided the proposed amendment has been published in two successive issues of SCHOOL SCIENCE AND MATHEMATICS.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2140. *Francis L. Miksa, Aurora, Ill.*

2137–9; 2160–7. *Prasert Na Nagara, College of Agriculture, Bangkhen, Bangkok, Thailand.*

2143. *Proposed by Norman Anning, University of Michigan.*

Establish the identity:

$$\sin P \sin Q + \sin R \sin (P+Q+R) = \sin (P+R) \sin (Q+R).$$

Solution by V. C. Bailey, Evansville College, Evansville, Ind.

Use the identity,

$$\sin x \sin y = \tfrac{1}{2}\left[\cos (x-y) - \cos (x+y)\right],$$

and substitute in the left member of the given expression.

$$\tfrac{1}{2}\left[\cos (P-Q) - \cos (P+Q)\right] + \tfrac{1}{2}\left[\cos (P+Q) - \cos (P+Q+2R)\right] = \tfrac{1}{2}\left[\cos (P-Q) - \cos (P+Q+2R)\right] = -\sin (P+R) \sin (-Q-R) = \sin (P+R) \sin (Q+R)$$

Solutions were also sent in by: W. J. Blundon, St. John's, Newfoundland; Alan Wayne, Flushing, N. Y.; W. J. Cherry, Beruyn, Ill.; C. W. Trigg, Los Angeles City College; W. R. Talbot, Jefferson City, Mo.; Cecil B. Read, University of Wichita; John Winslow and Harlan Weitzel, Pasadena, Calif.; Gerald Sabin, University of Tampa; Melvin Novick, Chicago; John A. Beemster, Ep-

worth, Iowa; Adrian Struyk, Paterson, N. J.; S. E. Field, Ironwood, Mich.; Hugo Brandt, University of Md.; Norma Steight, Winnetka, Ill.; Max Beberman, Shanks Village, N. Y.; A. MacNeish, Chicago.

2144. *Proposed by Felix John, Ammendale, Md.*

Show that $n^{13}-n$, for every n, has the factor 2730.

Solution by C. W. Trigg, Los Angeles City College

A corollary of Fermat's Theorem states that "if p is a prime and n is any integer, $n^p-n\equiv 0 \pmod{p}$.

Now

$$n^{13}-n=n(n^4-n^2+1)(n^2+1)(n^2-n+1)(n+1)(n^2+n+1)(n-1).$$

By combining the appropriate factors we have,

$$n^{13}-n=A(n^7-n)=B(n^5-n)=C(n^3-n)=D(n^2-n).$$

It follows that $n^{13}-n$ is divisible by $13\cdot 7\cdot 5\cdot 3\cdot 2$ or 2730.

Solutions were also sent in by: W. J. Cherry, Berwyn, Ill.; Felix John, Ammendale, Md.; W. J. Blundon, St. John's, Newfoundland; Max Beberman, Shanks Village, N. Y.; Aaron Buchman, Buffalo, N. Y.; Hugo Brandt, University of Md.; Adrian Struyk, Paterson, N. J.; Marilyn McCarthy, Chicago.; W R. Talbot, Jefferson City, Mo.; Francis L. Miksa, Aurora, Ill.

2145. *Proposed by Olive Ireland, St. Albans, Vt.*

In the "ambiguous" case of plane triangles, show that the circumcircles of the two triangles are equal.

Solution by A. MacNeish, Chicago

Given sides a and c and $\angle A$, with $a<c$ but $a>c \sin A$

These are the conditions for the "ambiguous" case.

The two triangles are ABC and $A'B'C'$ in which $BC=a$, and $B'C'$ also $=a$, $\angle A=\angle A'$

The segment with the chord $=a$ and inscribed $\angle =A$, will have both triangles ABC and $A'B'C'$ inscribed in it, so the segment completed will form a circle which circumscribes both triangles.

Second solution

Since

$$R=\frac{a}{2\sin A},$$

the circumscribed circles are equal.

Solutions were also sent in by: Max Beberman, Shanks Village, N. Y.; Norma Steight, Winnetka, Ill., Adrian Struyk, Paterson, N. J.; S. E. Field, Ironwood, Mich.; Gerald Sabin, University of Tampa; V. C. Bailey, Evansville, Ind.; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles City College; W. J. Cherry, Berwyn, Ill.; W. J. Blundon, St. John's, Newfoundland.

2146. *Proposed by Clara Luce, Chevy Chase, Maryland.*

If the sides of a triangle be in arithmetic progression, and if a is the shortest side, prove

$$\cos A=\frac{4c-3b}{2c}.$$

Solution by W. R. Talbot, Jefferson City, Missouri

Let the sides be a, $b=a+d$, and $c=a+2d$. By the Law of Cosines

$$\cos A=\frac{b^2+c^2-a^2}{2bc}=\frac{a^2+6ad+5d}{2bc}=\frac{(a+5d)(a+d)}{2bc}=\frac{a+5d}{2c}.$$

The given relation follows at once since

$$a+5d=4(a+2d)-3(a+d)=4c-3b.$$

Solutions were also sent in by: Norma Sleight, Winnetka, Ill.; W. J. Blundon, St. John's, Newfoundland; V. C. Bailey, Evansville, Ind.; C. W. Trigg, Los Angeles City College; W. J. Cherry, Berwyn, Ill.; Margaret Joseph, Milwaukee, Wis.; A. MacNeish, Chicago; Max Beberman, Shanks Village, N. Y., Hugo Brandt, University of Md.; S. E. Field, Ironwood, Mich., Gerald Sabin, University of Tampa; John Winslow, Pasadena, Calif.; David Freeman, Mill Valley, Calif.; John A. Beemster, Epworth, Iowa; Walter R. Warne, Alton, Ill.; F. L. Miksa, Aurora, Ill.

2147. *Proposed by Lillian A. MacDonald, Newark, N. J.*

If D_p is the difference between the sum of the pth powers of the first n consecutive even numbers and the sum of the pth powers of the consecutive odd numbers up to n, show that $2D_8+12D_6+2D_4$ equals the fourth power of a whole number.

Solution by C. W. Trigg, Los Angeles City College

Let the sums of the p^{th} powers of the first n integers, of the first n odd integers, and of the first n even integers be represented by $S_p{}^n$, $S_p{}^{n,o}$ and $S_p{}^{n,e}$, respectively. Then

$$S_p{}^{2n}=S_p{}^{n,o}+S_p{}^{n,e}.$$

Thence,

$$D_p=S_p{}^{n,e}-S_p{}^{n,o}=S_p{}^{n,e}-(S_p{}^{2n}-S_p{}^{n,e})=2S_p{}^{n,e}-S_p{}^{2n}=2^{p+1}S_p{}^n-S_p{}^{2n}.$$

The formulas for $S_p{}^k$) for specific values of p may be obtained from the general expression

$$S_p{}^k=\frac{k^{p+1}}{p+1}+\frac{k^p}{2}+\frac{B_1}{2!}pk^{p-1}-\frac{B_2}{4!}p(p-1)(p-2)k^{p-3}+\cdots,$$

where the terms in k^0 and those that follow are omitted. The B_i are Bernoulli's numbers.

Thus

$$S_4{}^k=(6k^5+15k^4+10k^3-k)/30.$$

Then

$$\begin{aligned}D_4&=2^5(6n^5+15n^4+10n^3-n)/30-[6(2n)^5+15(2n)^4+10(2n)^3-2n]/30\\&=[6n^5(2^5-2^5)+15n^4(2^5-2^4)+10n^3(2^5-2^3)-n(2^5-2)]/30\\&=8n^4+8n^3-n.\end{aligned}$$

In like manner,

$$S_6{}^k=(6k^7+21k^6+21k^5-7k^3+k)/42,$$

so

$$D_6=32n^6+48n^5-20n^3+3n;$$

and

$$S_8{}^k=(10k^9+45k^8+60k^7-42k^5+20k^3-3k)/90$$

so

$$D_8=128n^8+256n^7-224n^5+112n^3-17n.$$

It follows that

$$2D_8+12D_6+2D_4=256n^8+512n^7+384n^6+128n^5+16n^4=[2n(2n+1)]^4.$$

Solutions were also sent in by: W. J. Blundon, St. John's, Newfoundland; F. L. Miksa, Aurora, Ill.

2148. *Proposed by Francis L. Miksa, Aurora, Ill.*

Find the smallest set of three Pythagorean triangles whose perimeters are equal.

Solution by Adrian Struyk, Paterson, N. J.

The common perimeter of the triangles sought is the *L. C. M.* of the perimeters of three primitive Pythagorean triangles. Such primitives (ABC) are obtained by taking $a=m^2-n^2$, $b=2mn$, $c=m^2+n^2$, where m and n are relatively prime integers not both odd, and m greater than n. Then the perimeter is given by $p=2m(m+n)$. Systematic tabulation of m and n with the corresponding values of p yields the following results:

$$m=\ 2,\ 3,\ 4,\ 4,\ 5,\ 5,\ 6,\ 6,\ 7,\ 8,\cdots$$
$$n=\ 1,\ 2,\ 1,\ 3,\ 2,\ 4,\ 1,\ 5,\ 2,\ 1,\cdots$$
$$p=12,\ 30,\ 40,\ 56,\ 70,\ 90,\ 84,\ 132,\ 126,\ 144,\cdots.$$

Since the first three values of p have 120 as their *L. C. M.* the tabulation need not be carried past the point where it becomes certain that every p exceeds 120. If no smaller *L. C. M.* appears for any three values of p up to this point, then we have the solution at hand. Since this is what happens the required triangles are:

30, 40, 50; 20, 48, 52; 24, 45, 51.

Solutions were also sent in by: W. J. Blundon, St. Johns, Newfoundland; A. MacNeish, Chicago; Max Beberman, Shanks Village, N. Y.; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles City College; Hugo Brandt, University of Md.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

2143. *George Bray, Winnetka, Illinois*

2145, 6. *Phillip Zeidenberg, Brooklyn.*

2143. *Robert Hinds, Don Havranek, Orville Schaeffer, Arlington Heights, Illinois.*

PROBLEMS FOR SOLUTION

2161. *Proposed by Adrian Struyk, Paterson, N. J.*

A regular hexagon $ABCDEF$ is given. AB is extended through B to B', BC through C to C', CD through D to D', etc. Show how to construct equal extensions of such length that the area $A'B'C'D'E'F'$ will be twice the area of $ABCDEF$.

2162. *Proposed by Norman Anning, University of Mich.*

The line $y=x\tan\alpha$ and cuts $x^2+y^2=6x+8y$ in 0 (o, o) and in B. If A is $(6, o)$, show that $AB=10\sin\alpha$

2163. *Proposed by Roy Wild, University of Chicago.*

Show that

$$\frac{1}{\sin^2\theta}=\frac{1}{\theta^2}+\frac{1}{\left(2\cos\frac{\theta}{2}\right)^2}+\frac{1}{\left(4\cos\frac{\theta}{4}\right)^2}+\frac{1}{\left(8\cos\frac{\theta}{8}\right)^2}+\cdots.$$

2164. *Proposed by R. E. Horton, Los Angeles.*

Find the equations of the circles through points (2, 0) and (82/89, 60/89), that are tangent to the circle $x^2+y^2=1$.

2165. *Proposed by Hugo Brandt, College Park, Md.*

In a 5-place table of logarithms for trigonometric functions there is a range in which the log cos α increases 1 unit in the 5th place, if α decreases 1′. For which angle is this property most nearly true.

2166. *Proposed by Olive Ireland, St. Albans, Vt.*

In triangle ABC, if D be the mid point of BC and if Δ is the area, show that

$$\cot \angle ADB=\frac{b^2-c^2}{4\Delta}.$$

BOOKS AND PAMPHLETS RECEIVED

PRINCIPLES OF ORGANIC CHEMISTRY, by James English, Jr., Ph.D., *Associate Professor of Chemistry, Yale University*, and Harold G. Cassidy, Ph.D., *Associate Professor of Chemistry, Yale University*. Cloth. Pages xiii+512. 14.5×22.5 cm. 1949. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $5.00.

THE WORLD OF LIFE. A General Biology, by Wolfgang F. Pauli, *Bradford Junior College, Bradford, Massachusetts*. Cloth. Pages x+653. 17×24 cm. 1949. Houghton Mifflin Company, 2 Park Street, Boston, Massachusetts. Price $5.00.

THE WORLD AS I SEE IT, by Albert Einstein. Translated by Alan Harris. Cloth. Pages xiii+112. 9.5×16.5 cm. 1949. The Philosophical Library, Inc., 15 East 40th Street, New York. 16, N. Y. Price $2.75.

TV PICTURE PROJECTION AND ENLARGEMENT, by Allan Lytel, *Lecturer, Temple University, Technical Institute*. Cloth. Pages xi+179. 13.5×21.5 cm. 1949. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $3.50.

VARIABILITY IN RECOGNIZING SCIENTIFIC INQUIRY. An Analysis of High School Science Textbooks, by Richard H. Lampkin, Ph.D., Cloth. Pages ix+79. 15×23 cm. 1949. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $2.10.

FIRST-YEAR MATHEMATICS FOR COLLEGES, by Paul R. Rider, *Professor of Mathematics, Washington University, St. Louis, Missouri*. Cloth. Pages xv+714. 13.5×21 cm. 1949. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $5.00.

MATHEMATICS YOU NEED, by Eugenie C. Hausle, *Chairman, Mathematics Department, James Monroe High School, Bronx, New York City;* Benjamin Braverman, *Chairman, Mathematics Department, Seward Park High School, New York City;* Harry Eisner, *Principal, Franklin K. Lane High School, Brooklyn, New York City;* and Max Peters, *Chairman, Mathematics Department,*

Long Island City High School, Queens, New York City. Cloth. Pages viii+376. 13×20.5 cm. 1949. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $1.96.

PLANE GEOMETRY EXPERIMENTS, by Allene Archer, *Thomas Jefferson High School, Richmond Virginia;* Miles C. Hartley, *Assistant Professor of Mathematics, College of Education, University of Illinois;* and Veryl Schult, *Head of Department of Mathematics, Public Schools (Div. 1–9), Washington, D. C.* Paper. Pages vi+78+28. 18.5×26 cm. 1949. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price 96 cents.

SPHERES AND CUBES AS DOUBLED VOLUMES, by Charles Cressey, *Architect.* Paper. 17 pages. 15×23 cm. 1949. Charles Cressey, 2135—28th Avenue, San Francisco 16, Calif. Price $1.00.

THE A.R.R.L. ANTENNA BOOK, by the Headquarters Staff of the American Radio Relay League. Fifth Edition. Paper. 288 pages. 15.5×24 cm. 1949. The American Radio Relay League, Inc., West Hartford, Conn. Price $1.00 in the United States, its Possessions, and Canada; $1.25 elsewhere.

INSTRUCTIONAL TESTS IN ALGEBRA, by Raleigh Schorling, *Head of Department of Mathematics, University of Michigan.* Revised Edition. Paper. Pages viii+88. 14×20.5 cm. 1949. World Book Company, Yonkers-on-Hudson, N. Y. Price 40 cents.

MANUAL FOR GROVE'S MOTO-MATH. Paper. 30 pages. 21.5 ×28 cm. 1949. Yoder Instruments, East Palestine, Ohio. Price 30 cents.

LIFE ON OTHER WORLDS, by H. Spencer Jones, M.A., Sc.D., F.R.S., *Astronomer Royal; Honorary Fellow, Jesus College, Cambridge.* Paper. Pages viii+160. 10.5×18 cm. 1949. The New American library of World Literature, Inc., 245 Fifth Avenue, New York 16, N. Y. Price 35 cents.

SCIENCE TEACHING IN RURAL AND SMALL TOWN SCHOOLS, by Glenn O. Blough, and Paul E. Blackwood, *Specialists in Elementary Science.* Bulletin 1949, No. 5. Pages vi+55. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

STATISTICAL SUMMARY OF EDUCATION, 1945–46, by David T. Blose, *Associate Specialist in Educational Statistics under the Direction of Emery M. Foster, Head, Reports and Analysis Branch, Research and Statistical Service.* Paper. Pages vii+40. 14.5×23.5 cm. 1949. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.

CLASS SIZE: THE LARGER HIGH SCHOOL, by Ellsworth Tompkins, *Specialist for Large High Schools.* Paper. Pages vi+29. 20 ×26 cm. 1949. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

EDUCATION IN BOLIVIA, by Raymond H. Nelson, *Specialist on Education in Latin American Countries, American Republics Section, Division of International Educational Relations.* Paper. Pages vi+90. 14.5×23.5 cm. 1949. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 25 cents.

COMICS, RADIO, MOVIES—AND CHILDREN, by Josette Frank, *Educational Associate in Charge of Children's Books and Radio on the Staff of the Child Study Association of America.* Paper. 32 pages. 13.5×21.5 cm. 1949. Public Affairs Committee, Inc., 22 East 38th Street, New York 16, N. Y. Price 20 cents.

A LABORATORY BOOK OF ELEMENTARY ORGANIC CHEMISTRY, by Alexander Lowy, Ph.D., *Late Professor of Organic Chemistry,* and Wilmer E. Baldwin,

Ph.D., *Associate Professor of Organic Chemistry, University of Pittsburgh.* Third Edition. Paper. Pages xi+186. 21×28 cm. 1949. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.00.

A BIBLIOGRAPHY OF MATHEMATICAL EDUCATION, by William L. Schaaf, Ph.D., *Assistant Professor of Education, Brooklyn College.* Paper. Pages viii+144. 15×23 cm. 1941. Stevinus Press, P. O. Box 33, Forest Hills, N. Y.

MATHEMATICS AT WORK. High Lights of the Eighth Annual Mathematics Institute. W. W. Rankin, *Director, and Professor of Mathematics, Duke University.* Paper. 94 pages. 21×28 cm. Duke University, Durham, N. C.

EVALUATING AND REPORTING STUDENT PROGRESS IN BUSINESS EDUCATION, by Clyde W. Humphrey, *Business Education Service, Division of Vocational Education,* and Marion M. Lamb, *School of Business Administration, University of Houston, Houston, Texas.* Paper. Pages iv+16. 14.5×23 cm. Superintendent of Documents U. S. Government Printing Office, Washington 25, D. C. Price 10 cents.

LABORATORY EXERCISES, Biology of Plants, by H. L. Dean, *Department of Botany, State University of Iowa.* Loose Leaf. Pages v+265. 21×28 cm. 1949. Wm. C. Brown Company, 915 Main Street, Dubuque, Iowa. Price $1.75.

GENERAL EDUCATION BOARD, founded by John D. Rockefeller. Annual Report 1947–1948. Paper. 304 pages. 14×22 cm. General Education Board, 49 West 49th Street, New York, N. Y.

BOOK REVIEWS

MINERALS AND HOW TO STUDY THEM, by The Late Edward Salisbury Dana. Third Edition, Revised by Cornelius S. Hurlbut, Jr. Ph.D., *Associate Professor of Mineralogy, Harvard University.* Cloth. Pages x+323. 13.5×20.5 cm. 1949. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.90.

This book by Mr. Hurlbut is a revision of the famous book by Dana which originally appeared in 1895—one of the first books in the field written for the amateur. In its present form it contains much that is new both in substance and in method of presentation. The entire discussion is presented in a form most useful in the identification of minerals, which many diagrams, photographs, and tables of related data. Minor changes only have been made in the sections on crystallography and the physical properties of minerals but a valuable section on growing crystals has been added. The chapters on chemical properties and the use of the blowpipe have been shortened making it possible to add much to the sections on description of minerals without greatly increasing the length of the book. New material has been added bringing the book up to date and putting it in the most suitable form to prepare the student for future work in the subject.

G. W. W.

PRACTICAL TELEVISION SERVICING, by J. Richard Johnson, *Formerly Managing Editor, "Radio Maintenance Magazine";* and J. H. Newitt, *Formerly Project Engineer, Federal Telecommunications Laboratory.* Cloth. Pages vii+334. 14.5×23 cm. 1949. Murray Hill Books, Inc., 232 Madison Avenue, New York 16, N. Y. Price $4.00.

The authors of this book are two practical men in the operation and care of all television equipment. They first give a clear, concise explanation of the processes involved in television receivers so that the service man will work with a

clear understanding of what is involved in the equipment he is attempting to set up and put in working order. The first half or more of the book gives an excellent explanation of the entire receiving process, describing in detail all the important parts of the apparatus. Each part such as the r-f amplifier, the i-f parts, the mixer detectors, cathode ray tubes, video amplifiers, synchronizing parts, and all the minor details are described and explained so that the service man can do an intelligent and thorough job. The latter part of the book discusses the tools and equipment needed, the installation of antenna, the safety measures involved, the precautions necessary to avoid errors, wiring techniques, antenna design and installation, and all other parts of the receiving set. A full chapter is devoted to troubleshooting and another to servicing hints and case histories. An excellent glossary forms part of the appendix. All service men will become more proficient by knowledge and use of this book.

G. W. W.

ELEMENTARY INDUSTRIAL ELECTRONICS, by William R. Wellman, Cochairman, Radio Department, George Westinghouse Vocational High School, New York City. Cloth. Pages ix+371. 15×23 cm. 1948. D. Van Nostrand Co., Inc., New York, New York. Price $3.20.

This textbook on electronic devices and circuits is intended to introduce the reader to "the basic principles involved in electronic equipment now in industrial use." After a chapter on alternating-current fundamentals, the principles of vacuum tubes and of gas-filled tubes are treated. The remainder of the book is devoted to the equipment in which these elements are used—rectifiers, amplifiers, high-frequency heating equipment, control devices for motors and generators and for welding equipment, photoelectric applications, and electronic lamps. Each chapter is followed by a set of very simple questions, a useful summary, and a list of references for further reading. The principles described are illustrated by a set of 17 experiments that can be performed with simple equipment; in each case a complete list of the equipment required is provided.

The level of the book is elementary, although a considerable basis of direct-current theory is assumed. There is no mathematics. Many of the illustrations are good, but in some cases the agreement between text and illustration could have been improved. Some readers may be disturbed by the frequent use of the second personal pronoun, and others by the convention chosen for the direction of current. There are minor shortcomings in terminology and the use of English. It is, however, really disturbing to find that sound waves are included in the spectrum of radiant energy; it may also be noted that the high-frequency end of this spectrum is assigned to cosmic rays. There are a number of other spots in which the beginning student might well be confused, but the instructor could probably point them out and clarify them.

JOSEPH D. ELDER

FOUNDATIONS OF MODERN PHYSICS, Second Edition, by Thomas B. Brown, Professor of Physics, The George Washington University. Cloth. Pages xvi+391. 15×23 cm. 1949. John Wiley and Sons, Inc., New York, New York. Price $5.00.

This is the second edition of a well-known and very satisfactory college textbook on modern physics. It has been revised in many details, and enlarged to include the fundamental developments, particularly in microwaves and nuclear physics, that have taken place since the publication of the first edition, in 1940, including of course the "atom" bomb. The author points out quite rightly that the first edition contained a description of the experimental basis on which the so-called secret of the bomb rests.

As in the first edition, the emphasis is on the foundations—that is, the experiments that initiated the modern developments, and the evidence that they give in support of the new theories. The book differs from many others in the same field by abandoning the chronological order for the one that seems most logical in the

light of modern knowledge. Those who have grown up with physics during all or part of the period of rapid advance covered by this book may find this treatment somewhat strange, but the author is doubtless justified in feeling that it simplifies matters for the beginning student.

The book begins with Millikan's oil-drop experiment; this is followed by sections on the properties and uses of the electron. The next chapter presents the evidence for the nuclear picture of the atom. Then come four chapters on light and electromagnetic radiations, followed by a discussion of the wave-particle duality. This serves to introduce the topics of spectra and atomic structure. Four chapters on molecules, crystals, and black-body radiation skillfully weave together classical theories, their shortcomings, and the modern outgrowths. These are followed by four chapters on radioactivity and the atomic nucleus, and the book concludes with a discussion of cosmic rays.

The level of the treatment is suited to a student who has had a year's course in general college physics. Even so, it is not assumed that the student will remember all he learned in that course, and there is sufficient review to give him a proper orientation for each main topic. The only mathematics used is algebra and a minimum of trigonometry. The treatments are, however, quantitative and exact, even though in simple terms and limited where necessary to special cases. The student who uses this book will not be confused by looseness either of thought or of expression on the part of the author. If later he has to unlearn anything from the book, it will be because of the advance of knowledge, not the author's inaccuracy.

Each chapter is accompanied by references for further reading, carefully chosen to suit the needs of both elementary and advanced students. Each chapter is also provided with a set of problems, not of the substitution-in-formula type but intended to test and assist the student's grasp of the physical reasoning. By judicious omissions the book could be adapted to a one-semester course, but there is ample material for a full year.

JOSEPH D. ELDER

EXPLORING BIOLOGY, by Ella Thea Smith, *High School, Salem, Ohio.* Cloth. Pages xi+607. 23.5×16 cm. 364 illustrations. 1949. Harcourt, Brace, and Company, New York.

This is the third edition of a much used high school biology text. In its revised edition it contains an expanded discussion on the chemical nature of life processes, and new additions include sections on human physiology and human health. Every topic has been worked over carefully to give students benefit of the most recent achievements.

The book is divided into ten units considering the following topics: the cell, a survey of the plant and animal kingdoms, chemical nature of life, human physiology, human diseases—causes and controls, behavior of living things, reproduction, heredity, evolution, and conservation—emphasizing an ecological approach. At the end of the book there is an adequate glossary of terms.

Each chapter is concluded with work book problems for use as individual and class projects, and there is a list of thought problems based on the material taken up in the chapter. All of the illustrations are in black and white and are accompanied by descriptions and questions to make them serve as valuable companions to the text.

GEORGE S. FICHTER
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